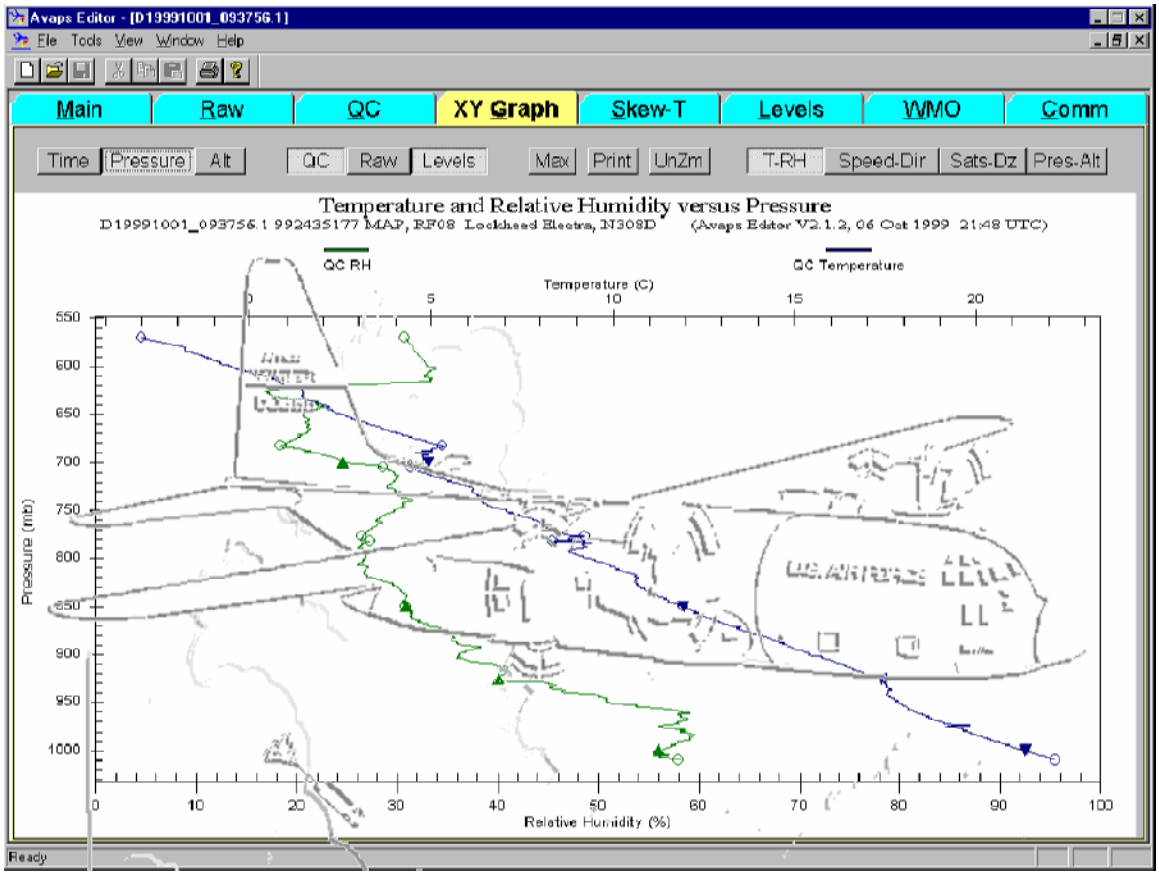
# ASPEN

(ATMOSPHERIC SOUNDING PROCESSING ENVIRONMENT)

# USER MANUAL


Avaps Editor - [D19991001_093756.1]
File Tools View Window Help
Main Raw QC XY Graph Skew-T Levels WMO Comm
Time Pressure Alt QC Raw Levels Max Print UnZm T-RH Speed-Dir Sats-Dz Pres-Alt
Temperature and Relative Humidity versus Pressure
D19991001_093756.1 992435177 MAP, RF08 Lockheed Electra, N308D (Avaps Editor V2.1.2, 06 Oct 1999 21:48 UTC)
QC RH
QC Temperature
Temperature (C)
Pressure (mb)
Relative Humidity (%)
Ready


Charles Martin

National Center for Atmospheric Research
Boulder, Colorado 80307-3000



January 2004

# COPYRIGHT

© 2005 University Corporation for Atmospheric Research. All rights reserved.

No part of this manual may be reproduced (electronically or photocopied), translated into another language, or duplicated by any means without prior written consent of the University Corporation for Atmospheric Research (UCAR).

All information contained in this manual is subject to change, without notice.

# Table of Contents

**Introduction** ..... **1**

**Overview of Operation** ..... **3**

**Post-Processing Adjustment** ..... **5**

End of data ..... 5

Dropsonde heights and the surface ..... 5

Launch parameters ..... 6

Setting the QC parameters ..... 6

**Tab Displays** ..... **8**

Sounding Identifier ..... 8

Main Tab ..... 8

Raw and QC Tabs ..... 9

XY Graph Tab ..... 10

Skew-T Tab ..... 12

Levels Tab ..... 13

WMO Tab ..... 14

Comm Tab ..... 15

**Menu Commands** ..... **17**

File Menu ..... 17

Tools Menu ..... 17

View Menu ..... 17

Window Menu ..... 17

Toolbar ..... 17

**Quality Control Procedures** ..... **18**

The Algorithms ..... 18

Guidelines for Adjusting QC Parameters ..... 23

**Configuration** ..... **26**

Configuration Set Management ..... 27

Changing the QC Parameters ..... 28

Other Options ..... 29

Saving Changes and Restoring Defaults ..... 32

Corrupted Configurations ..... 33

**BatchAspen** ..... **34**

Starting BatchAspen and Selecting Files ..... 34
Q/C Processing ..... 36
Q/C Parameters ..... 37
**AspenQC ..... 38**
Switches ..... 38
**Input File Types ..... 40**
**Appendix A: Configuration Parameters ..... 42**
**Appendix B: File formats ..... 48**
CLASS Format ..... 48
EOL Format ..... 48
NetCDF ..... 48
Comma Separated Values (CSV) ..... 48
**Appendix C: System Requirements ..... 51**
**Appendix D: netCDF Attributes ..... 52**

# List of Tables

Table 1. QC Processing Steps ..... 18
Table 2. Limit Check Bounds ..... 21
Table 3. Output File Types ..... 40
Table 4. Configuration Parameters ..... 47

# Introduction

Aspen (Atmospheric Sounding Processing Environment) is used for analysis and quality control (QC) of sounding data. It has the following capabilities:

- Automatically apply quality control procedures to the sounding data
- Present data in tabular and graphical forms
- Automatically determine levels and code them in WMO message formats
- Transmit the WMO messages to other systems
- Save the raw and derived data products in various formats

Since Aspen can process data provided in the AVAPS "D" file, NCAR GLASS, NCAR MCASS and NCAR CLASS formats, it is able to analyze both dropsonde and upsonde soundings.

Aspen is designed to operate as automatically as possible, while allowing the user to have some control over the QC methods. For instance, as soon as the user selects a sounding file for processing, the data is brought into Aspen and automatically analyzed. In most cases this first pass will be the only one required. If the processing needs to be modified, the user can change the QC parameters and reprocess the data as many times as necessary.

An extensive series of QC algorithms are applied to the data. These algorithms typically have one or two parameters that may be adjusted by the user if the default values are not suitable for a particular sounding. The user can save the modified options, so that when a new sounding is opened, the initial analysis will use the customized QC parameters.

Aspen can have up to six sounding files open at the same time. This makes it convenient to compare soundings.

Aspen is designed so that its operation requires minimal user intervention. However, there are a few concepts that are very helpful in understanding the behavior of the program.

***The QC process mainly removes suspect data points***

Aspen maintains two separate data sets: the raw data and the QC data. At the start of processing, the QC data is an exact copy of the raw data. The algorithms are then successively applied to the QC data. As the processing proceeds, data points that fail each test are removed from QC data set. At the end of this process, a final smoothing is applied to the remaining QC data. It is important to understand that ***nearly all of the QC steps simply remove unreliable points from the raw data set***. The dynamic adjustments and the final smoothing are the only steps where the observed data values are actually modified.

***Time is the independent variable***

A sounding is simply a time series of observations, and so almost all of the QC operations are based on the time of each data point. The QC parameters are specified in relation to time, and the tabular data listings are ordered by time.

***The processing follows a fixed sequence***

The complete processing routine is applied as soon as a sounding is selected for analysis, and whenever the user chooses to recompute the analysis. The sequence is as follows:

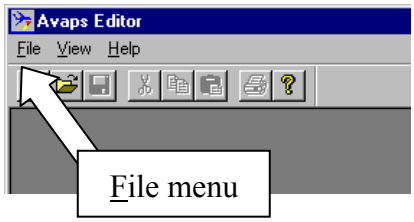
1) Apply the QC algorithms, discarding bad points and applying corrections
2) Compute the levels, by analyzing the QC results.
3) Code the WMO message, using the levels as input.

Throughout this manual, notes in *italics* provide additional information and suggestions which, while not essential to operation, will help you use Aspen more effectively.

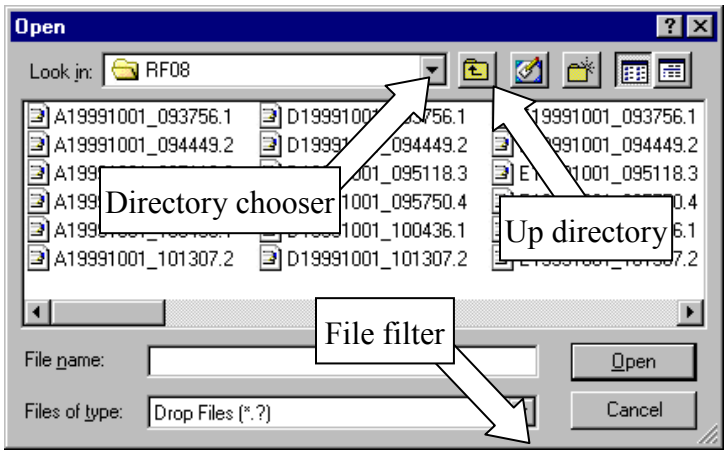
# Overview of Operation

1 **Run** To run Aspen, double click on the Aspen icon

, or choose Aspen from the start menu. An initial start screen will appear. If the file selector does not appear immediately, choose Open under the File menu:




You will now see the file selector:




The file selector is used to choose the sounding file to be processed. You can move to other directories using the up directory button or the directory chooser. The file filter controls the file types that are displayed in the chooser.

> *If you do not see your data files in the directory where they are supposed to be, it is probably because the file filter is set incorrectly. Change the file filter to "All files (*.*)" in order to display all files in the directory.*

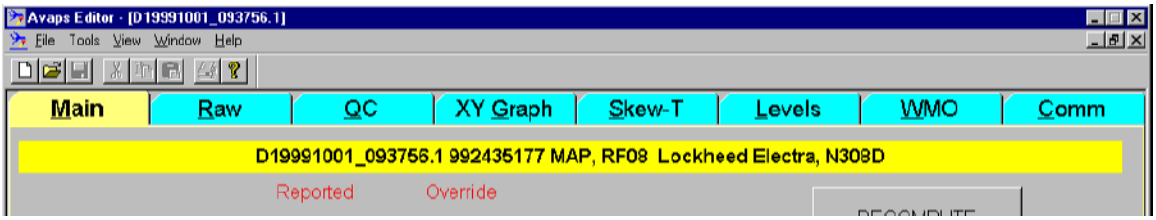
2 **Open**

Select the file containing the sounding that you want to analyze. Click once on the file and then press "Open", or double-click the file name.

*Aspen will show a warning message if you select a file that is in a format which it can't process.*

Processing of the sounding begins as soon as the file is opened. The progress of the analysis is displayed in the status box in the lower left hand corner of the main screen, but until the processing is complete, the screen will remain blank.

When the sounding analysis has completed, the initial screen will be filled with a tab-based display, in which each tab represents a different view of the data. The tabs are arranged from left to right (see figure below) in the general order of the data processing, i.e. from raw data, through the QC and levels computation, to the coded message. Read the **Tab Displays** section for further description.




3 **Verify**

Verify the sounding by examining all of the tab selections. Read the **Post-Processing Adjustment** section for important guidelines on doing this. After examining the sounding, the user may decide that one or more of the processing parameters should be adjusted.

4 **Recompute** (if necessary)

The most commonly altered processing parameters can be changed on the Main tab. When they have been set to the desired values, press the Recompute button on the Main Tab to reanalyze the sounding using the new parameters. The processing status will again be displayed in the lower left status box. When completed, the displays in each tab will be updated with the new results.

*Be sure to press the Recompute button after changing the processing parameters; otherwise, the new parameters will not be applied to the sounding.*

5 **Next Sounding**

To analyze another sounding, open another data file using the File⇑Open menu. Up to six soundings can be open at one time. Use the Window menu to choose which sounding is displayed.

# Post-Processing Adjustment

Once a sounding has been processed by Aspen, the results must be examined carefully. Frequently some parameters will need to be adjusted to compensate for characteristics of the data.

## *End of data*

In a well-behaved sounding, the end of the raw data set will occur at the end of the sounding. For a dropsonde landing in water, this is the usual case. For a dropsonde hitting the earth, or with upsondes, the raw data can contain observations that should not be included in the processed sounding. The user must then manually specify the end of the drop by setting the end of drop time on the Main tab. It is **critical** that the end of drop be correctly set for dropsonde soundings

The Raw data table and the XY graph are useful for determining the end time. Scroll to the bottom of the raw data to view the values of individual data points. On the XY graph, enable the raw data trace, and use the mouse to zoom in the area of the sounding end. Data point markers and grids can be enabled with buttons above the graph.

> *The QC tabular display will only show data points that are within the end of data time period.*

## *Dropsonde heights and the surface*

For dropsonde soundings, the height calculations are the trickiest part of the Aspen analysis. If the drop terminated cleanly at a known altitude, upward integration of the heights is straightforward. Upward integration is *impossible*, however, if the dropsonde termination altitude is unknown. This can occur if the drop did not make it all of the way to the surface, or if it the termination point on land had an unknown altitude (which is almost always the case).

In the latter situations, the sounding heights can be computed by downward integration from the launch altitude. Note that this suitable only if the launch altitude is known with accuracy. Usually the launch altitude is provided by the aircraft data system, and it is critical to determine the accuracy of this altitude. If altitude is provided by a radar altimeter over the ocean, it is probably acceptable. If it is provided by a pressure-based altimeter, at some time or distance since the altimeter setting was applied, the aircraft-provided altitude is probably not acceptable.

The Main tab has several items that relate to the height calculations. In the box labeled “Height Overrides” there are check buttons that have the following effects:

- Hit Surface – Check this check box if the dropsonde hit the surface. The heights will be integrated up from the surface altitude.

- Unknown Surface Altitude – Check this box if the surface altitude is unknown, such as when a dropsonde has terminated on land. The heights will be integrated down from the launch altitude.
- Set Heights Unknown – Check this box if you feel the heights are not sufficiently accurate, no matter which way they are calculated. The heights will not be calculated or used in latter processing.

At the lower right of the Main tab is a box displaying the results of the upward and downward height integrations. This is shown for diagnostic purposes. If downward integration leads to a launch altitude close to the surface altitude and, likewise, the upward integration is close to the launch altitude, then there is confidence in the launch altitude. If there are significant discrepancies, the launch altitude is probably incorrect. Additionally, differences in the diagnostics can signify a large systematic error in the variables used in the height integration, i.e. pressure, temperature or humidity.

If the surface altitude can be determined for a launch which terminated on land, this value can be entered into the surface altitude box, so that the upward integration can be computed.

The final item affecting the height calculation is the Launch Altitude entry in the Launch Parameters box in the upper left corner of the Main tab. If another source of the launch altitude is available, it may be entered here in order to override the aircraft supplied value. The Clear button can be used to remove the override.

It should be pointed out that the heights are mainly relevant to the coding of the WMO messages, where they are used to report the altitudes of standard pressure surfaces. Even if the heights are unusable, the WMO message will still contain a very accurate report of the sounding based on pressure. The upshot is to set heights to missing when in doubt, rather than report erroneous values.

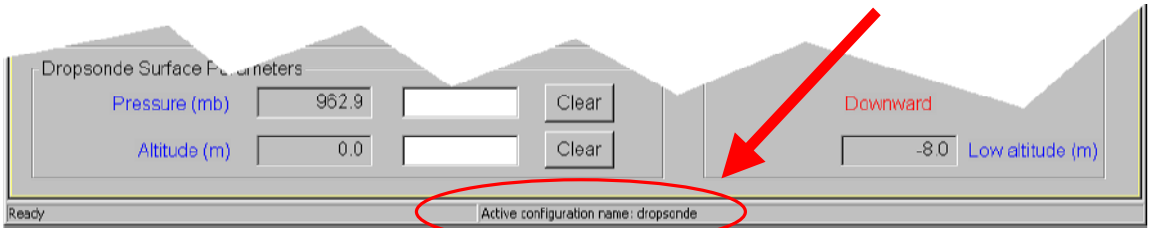
### *Launch parameters*

The launch parameters are the surface or aircraft flight level observation made at the time of launch. They become either the bottom or top point in the sounding, depending on the sounding direction. The QC procedures assume that these launch observations are accurate, so they will not be changed. If the launch observations do need to be modified, the Launch Parameters box in the upper left corner of the Main Tab has entries that allow the user to override them. Enter the new values into the boxes. Use the Clear button to revert to the original values. Be sure to hit “Recompute”.

### *Setting the QC parameters*

The QC parameters, which control the operation of the various QC algorithms, can be modified by the user. However, only experienced users who understand the effects of the parameters should do this. See the Quality Control Procedures section for a complete description.

The QC parameters are organized in named sets, with one of them designated as the currently ***active set***. The parameters in the active set are the ones used for succeeding analyses by Aspen. The active set name is displayed on the right side of the status bar at the bottom of the Aspen application window. It is visible for every Aspen tab:




The initial installation of Aspen provides a configuration set named "dropsonde", and designates it as active. These parameters are generally useful for dropsonde soundings in a tropical environment. If analyzing dropsonde soundings in different environments, as well as upsonde soundings, you will almost always need to create a new configuration set and adjust its QC parameters appropriately.

See the Configuration section for directions on setting the active set, maintaining configuration sets.

*The user should be in the habit of always checking the status bar to verify that the correct configuration set is designated as active.*

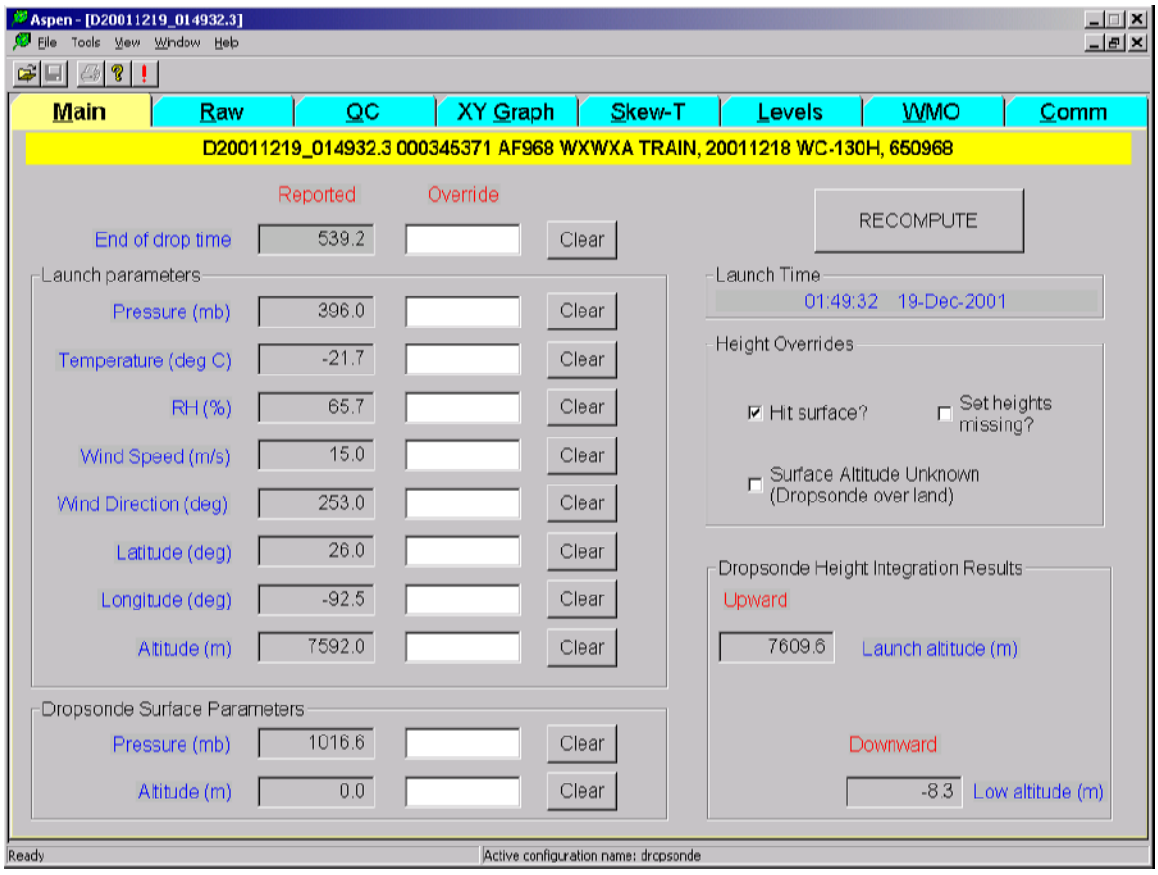
*To change the choice of active configuration set, close all sounding files within Aspen. The file menu will now have a "Configuration…" entry that allows access to the configuration editor.*

# Tab Displays

### *Sounding Identifier*

Each tab displays an identifier that describes the sounding. The details are extracted from various fields within the raw data file. For graphical displays, this information is printed as text on the graph. For other tabs, a yellow bar at the top of the tab contains the identification (see figure below).

## *Main Tab*

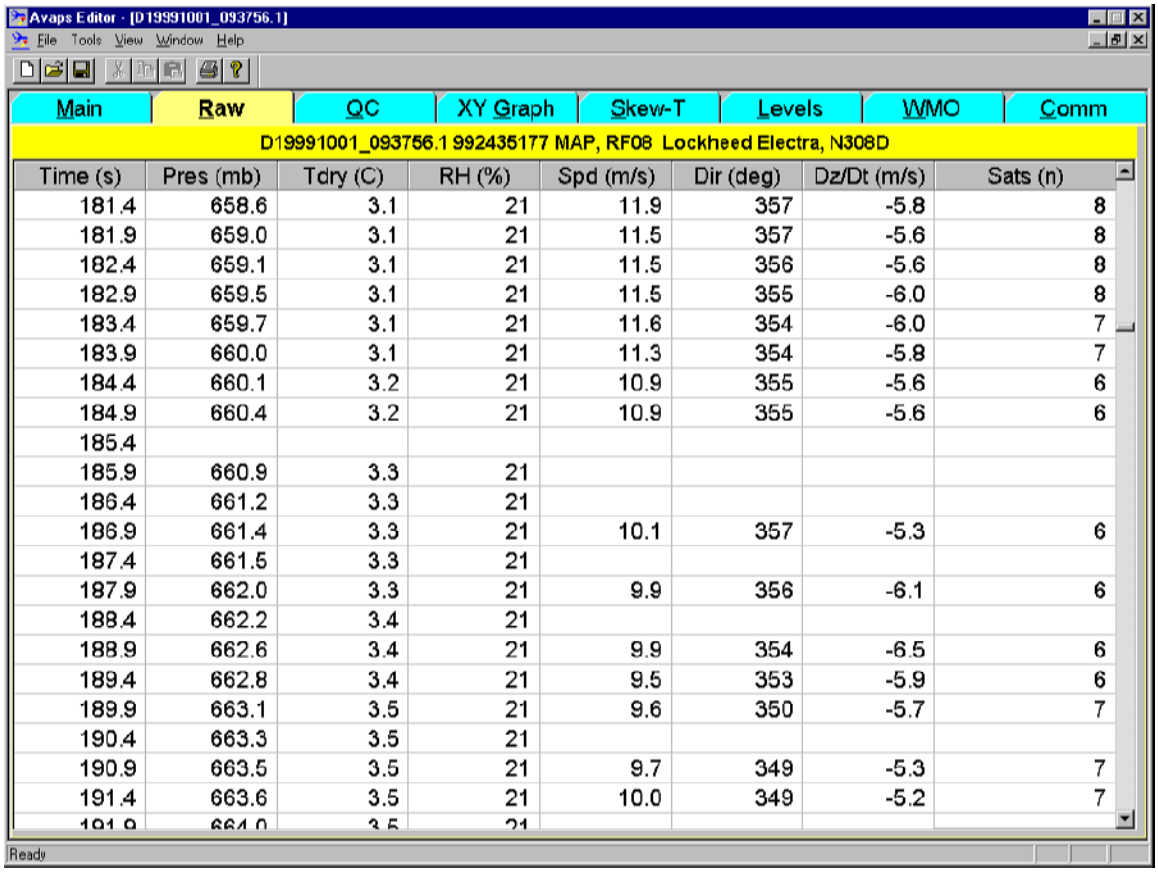



The Main tab is used to specify certain characteristics of the sounding, and to override the launch point observations. Entering a value into the appropriate box specifies the override. To remove the override, press the associated Clear button.

Directions for using the height-related controls is discussed in the **Post-Processing Adjustments** section.

Be sure to press "RECOMPUTE" after changing items on the Main tab.

## *Raw and QC Tabs*


Avaps Editor - [D19991001_093756.1]
File Tools View Window Help
Main Raw QC XY Graph Skew-T Levels WMO Comm
D19991001_093756.1 992435177 MAP, RF08 Lockheed Electra, N308D
Ready

| Time (s) | Pres (mb) | Tdry (C) | RH (%) | Spd (m/s) | Dir (deg) | Dz/Dt (m/s) | Sats (n) |
|---|---|---|---|---|---|---|---|
| 181.4 | 658.6 | 3.1 | 21 | 11.9 | 357 | -5.8 | 8 |
| 181.9 | 659.0 | 3.1 | 21 | 11.5 | 357 | -5.6 | 8 |
| 182.4 | 659.1 | 3.1 | 21 | 11.5 | 356 | -5.6 | 8 |
| 182.9 | 659.5 | 3.1 | 21 | 11.5 | 355 | -6.0 | 8 |
| 183.4 | 659.7 | 3.1 | 21 | 11.6 | 354 | -6.0 | 7 |
| 183.9 | 660.0 | 3.1 | 21 | 11.3 | 354 | -5.8 | 7 |
| 184.4 | 660.1 | 3.2 | 21 | 10.9 | 355 | -5.6 | 6 |
| 184.9 | 660.4 | 3.2 | 21 | 10.9 | 355 | -5.6 | 6 |
| 185.4 | | | | | | | |
| 185.9 | 660.9 | 3.3 | 21 | | | | |
| 186.4 | 661.2 | 3.3 | 21 | | | | |
| 186.9 | 661.4 | 3.3 | 21 | 10.1 | 357 | -5.3 | 6 |
| 187.4 | 661.5 | 3.3 | 21 | | | | |
| 187.9 | 662.0 | 3.3 | 21 | 9.9 | 356 | -6.1 | 6 |
| 188.4 | 662.2 | 3.4 | 21 | | | | |
| 188.9 | 662.6 | 3.4 | 21 | 9.9 | 354 | -6.5 | 6 |
| 189.4 | 662.8 | 3.4 | 21 | 9.5 | 353 | -5.9 | 6 |
| 189.9 | 663.1 | 3.5 | 21 | 9.6 | 350 | -5.7 | 7 |
| 190.4 | 663.3 | 3.5 | 21 | | | | |
| 190.9 | 663.5 | 3.5 | 21 | 9.7 | 349 | -5.3 | 7 |
| 191.4 | 663.6 | 3.5 | 21 | 10.0 | 349 | -5.2 | 7 |
| 191.9 | 664.0 | 3.5 | 21 | | | | |

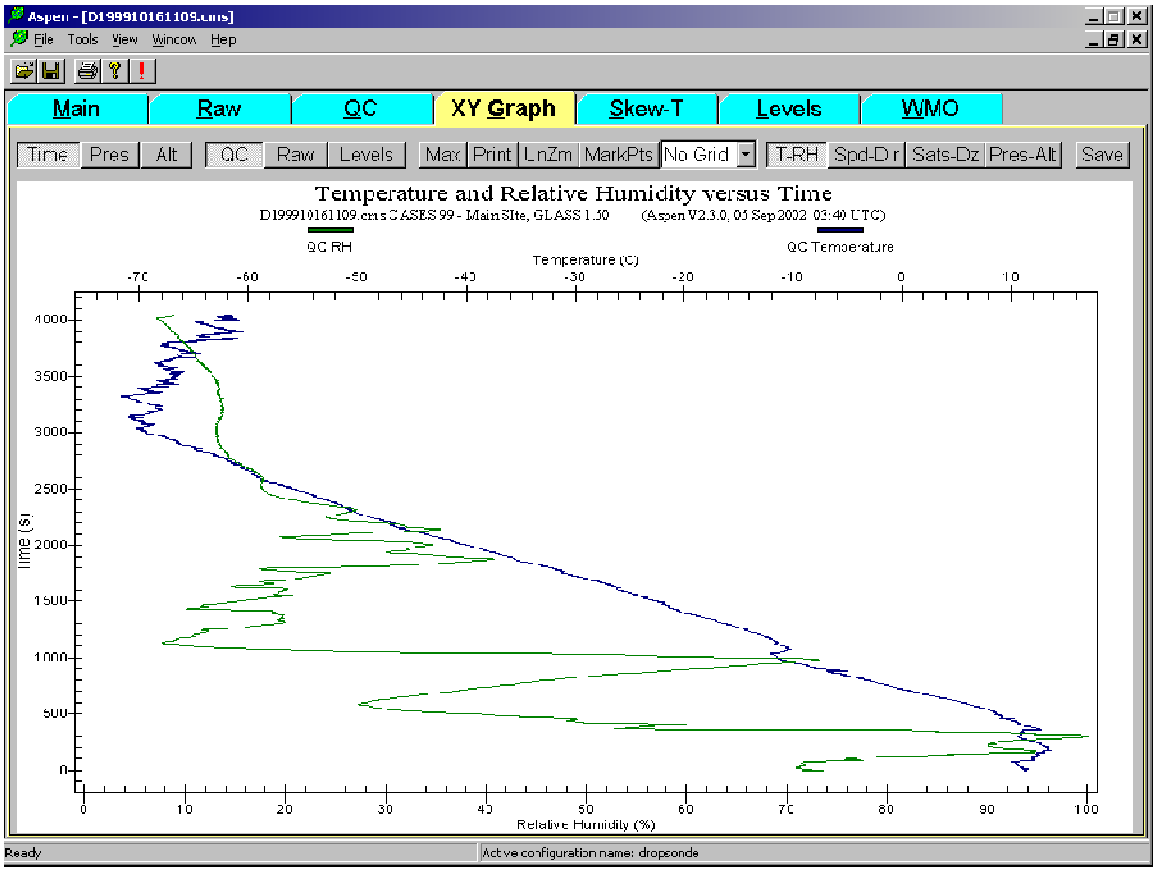
These two tabs each provide a table of data values. The data is listed in time order. The scrollbar on the right side is used to scroll up and down within the table. Notice that the pressure of the current scroll position is displayed as the scrollbar is moved.

The Print and Print Preview commands on the File menu are available for the Raw and QC tabs. The preview can be used to determine on which pages a particular range of data points falls. The Print command is used to print either the whole table or selected pages. The complete table for a sounding will range from 8 pages (drops from 700 mb) to upwards of 50 pages (upsondes to <100 mb).

The Save command allows the data to be saved in the NCAR CLASS or netCDF formats. The CLASS format produces an ASCII text file that can easily be imported into spreadsheets.

> *The launch observations are shown as the first line in the Raw and QC data displays. They will not be modified by the QC processing, but override values can be specified by the user.*

## *XY Graph Tab*


Aspen - [D19991016110...]
File Tools View Window Help
Main Raw QC XY Graph Skew-T Levels WMO
Time Pres Alt QC Raw Levels Max Print UnZm MarkPts No Grid T-RH Spd-Dr Sats-Dz Pres-Alt Save
Temperature and Relative Humidity versus Time
QC RH
QC Temperature
Temperature (C)
Time (s)
Relative Humidity (%)
Ready
Active configuration name: dropsonde

This tab provides numerous options for graphical display of the data. The buttons above the graph select which data products and parameters are displayed. The buttons also select the choice of vertical axis. The main options on the XY Graph tab are as follows:

**Time – Pres – Alt**. These buttons select the parameter displayed along the vertical axis. When the tab is first selected, time is chosen as the vertical axis, with only the QC data plotted. This leads to the "cleanest" display, since time uniformly increases in both the raw and QC data. When the raw data is displayed using the pressure or altitude axis, the display may be confusing due to noise in the raw pressure reading.

**Zoom - UnZm**. To magnify (zoom) an area of the plot, left-click and drag to draw a rectangle around the area of interest. Release the left mouse button to zoom into the defined area. The UnZm button restores the graph to the full area display.

*If the plot is zoomed into a particular area, and then the plot data type is changed, or a different vertical axis is selected, the plot area may go blank. This is because the zoom area is now in the wrong region for the new plot type. Hit the UnZm button to restore the plot to its full region.*

**Max**. The Max button can be pressed in order to expand the plot to the full screen of the monitor. Press the Esc key to bring the monitor back to the normal configuration.

**QC – Raw**. The QC and Raw buttons select the dataset(s) to be displayed in the graph. The two datasets can be displayed simultaneously. Conversely, if neither button is selected, no data will be displayed.

**Levels**. Pressing the Levels buttons causes the computed levels to be overlaid on the graph. Moving the mouse pointer over a level symbol will cause the level type to be displayed. Standard levels are displayed as triangles, and other levels are displayed as circles.

*Different levels types contain different sets of parameters. For instance, the standard levels report temperature, moisture, winds and altitude. On the T-RH plot, the standard levels will appear for any vertical axis choice. If the axis is set to altitude, however, the significant levels will not be shown here, since they are not reporting altitude. Also, if a particular field is missing from a level, it will not be overlaid on a trace. For instance, if a standard level does not have a temperature data value, it will not appear on the temperature trace.*

**Grids – MarkPts**. Grid overlays may be selected from the drop-down list above the graph. Marking of the data points can be toggled on and off using the MarkPts push button.

The four buttons on the far right select the parameters to be plotted along the horizontal axis:

**T – RH**. Selects temperature and relative humidity.

**Speed - Dir**. Selects wind speed and direction**.**

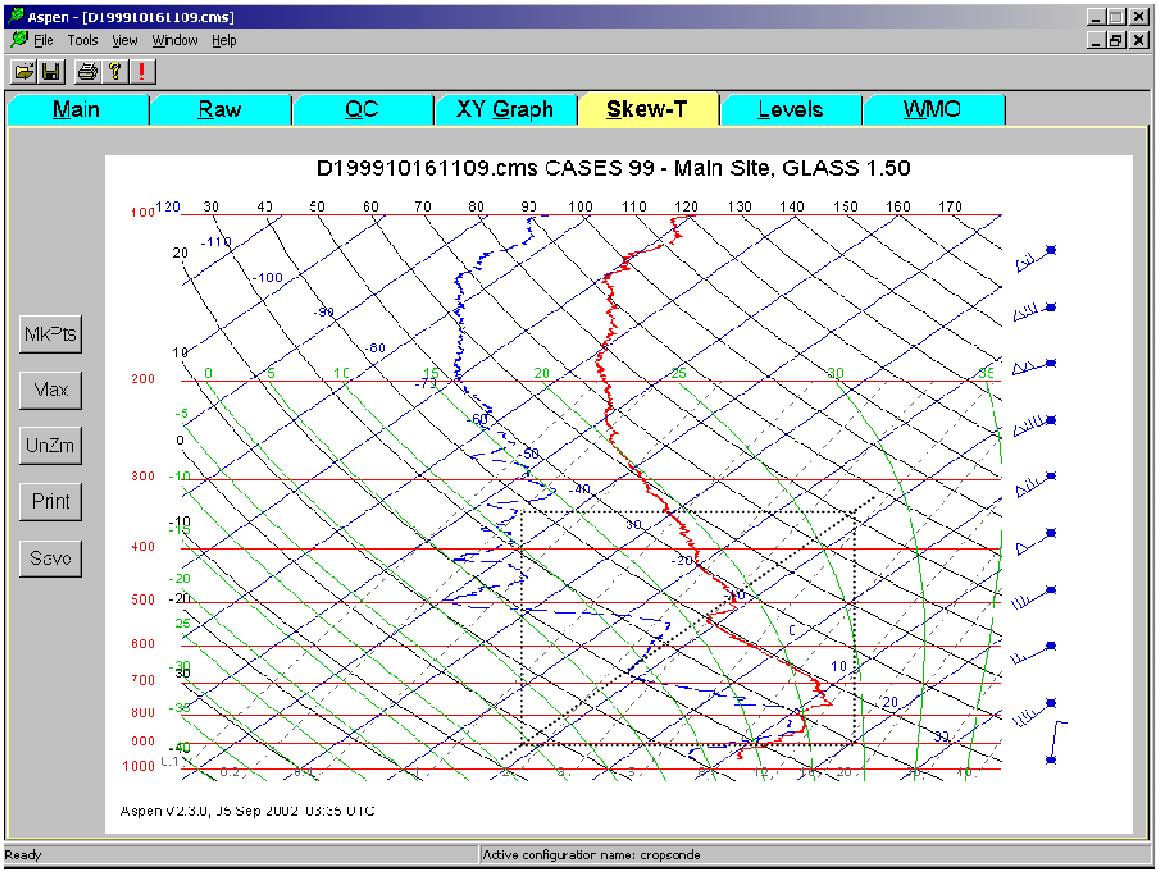
**Sats – Dz**. Selects number of satellites and ascent speed.

**Pres - Alt**. Selects pressure and altitude.

The Save button on the far right is used to save the graphic image as a PNG or JPEG file. PNG provides better compression and much higher quality graphics presentation for the line drawings of Aspen, and is the preferred file format. The pixel dimensions of the saved graphic file can be specified in the configuration options.

Other plotting options are available by holding down the right mouse button over the plot.

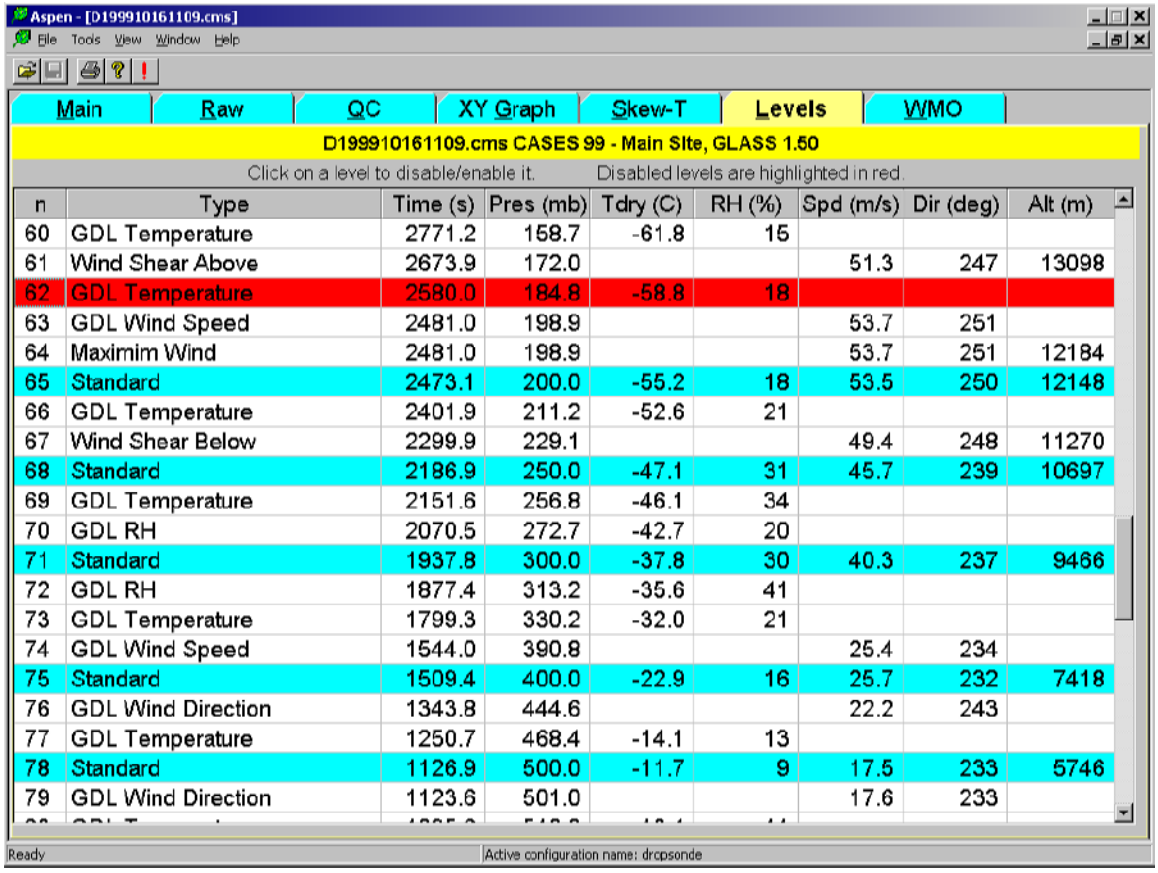
## *Skew-T Tab*




A standard skew-T log-P plot is accessed in the Skew-T tab. Zooming, maximizing, printing and saving of the plot are available in the same manner as for the XY Graph. The right mouse button brings up the same menu of plot options as well.

Meteorologists are accustomed to seeing a particular aspect ratio on skew-T plots and thus a consistent shape of the various isopleths. To maintain the correct aspect ratio when zooming, choose a zoom box whose lower left and upper right corners share a common temperature, i.e. they share a common diagonal. An example of a correct zooming rectangle is superimposed on the figure above.

## *Levels Tab*


Aspen - [D199910161109.cms]
File Tools View Window Help
Main Raw QC XY Graph Skew-T Levels WMO
D199910161109.cms CASES 99 - Main Site, GLASS 1.50
Click on a level to disable/enable it. Disabled levels are highlighted in red.
Ready
Active configuration name: dropsonde

| n | Type | Time (s) | Pres (mb) | Tdry (C) | RH (%) | Spd (m/s) | Dir (deg) | Alt (m) |
|---|---|---|---|---|---|---|---|---|
| 60 | GDL Temperature | 2771.2 | 158.7 | -61.8 | 15 | | | |
| 61 | Wind Shear Above | 2673.9 | 172.0 | | | 51.3 | 247 | 13098 |
| 62 | GDL Temperature | 2580.0 | 184.8 | -58.8 | 18 | | | |
| 63 | GDL Wind Speed | 2481.0 | 198.9 | | | 53.7 | 251 | |
| 64 | Maximim Wind | 2481.0 | 198.9 | | | 53.7 | 251 | 12184 |
| 65 | Standard | 2473.1 | 200.0 | -55.2 | 18 | 53.5 | 250 | 12148 |
| 66 | GDL Temperature | 2401.9 | 211.2 | -52.6 | 21 | | | |
| 67 | Wind Shear Below | 2299.9 | 229.1 | | | 49.4 | 248 | 11270 |
| 68 | Standard | 2186.9 | 250.0 | -47.1 | 31 | 45.7 | 239 | 10697 |
| 69 | GDL Temperature | 2151.6 | 256.8 | -46.1 | 34 | | | |
| 70 | GDL RH | 2070.5 | 272.7 | -42.7 | 20 | | | |
| 71 | Standard | 1937.8 | 300.0 | -37.8 | 30 | 40.3 | 237 | 9466 |
| 72 | GDL RH | 1877.4 | 313.2 | -35.6 | 41 | | | |
| 73 | GDL Temperature | 1799.3 | 330.2 | -32.0 | 21 | | | |
| 74 | GDL Wind Speed | 1544.0 | 390.8 | | | 25.4 | 234 | |
| 75 | Standard | 1509.4 | 400.0 | -22.9 | 16 | 25.7 | 232 | 7418 |
| 76 | GDL Wind Direction | 1343.8 | 444.6 | | | 22.2 | 243 | |
| 77 | GDL Temperature | 1250.7 | 468.4 | -14.1 | 13 | | | |
| 78 | Standard | 1126.9 | 500.0 | -11.7 | 9 | 17.5 | 233 | 5746 |
| 79 | GDL Wind Direction | 1123.6 | 501.0 | | | 17.6 | 233 | |

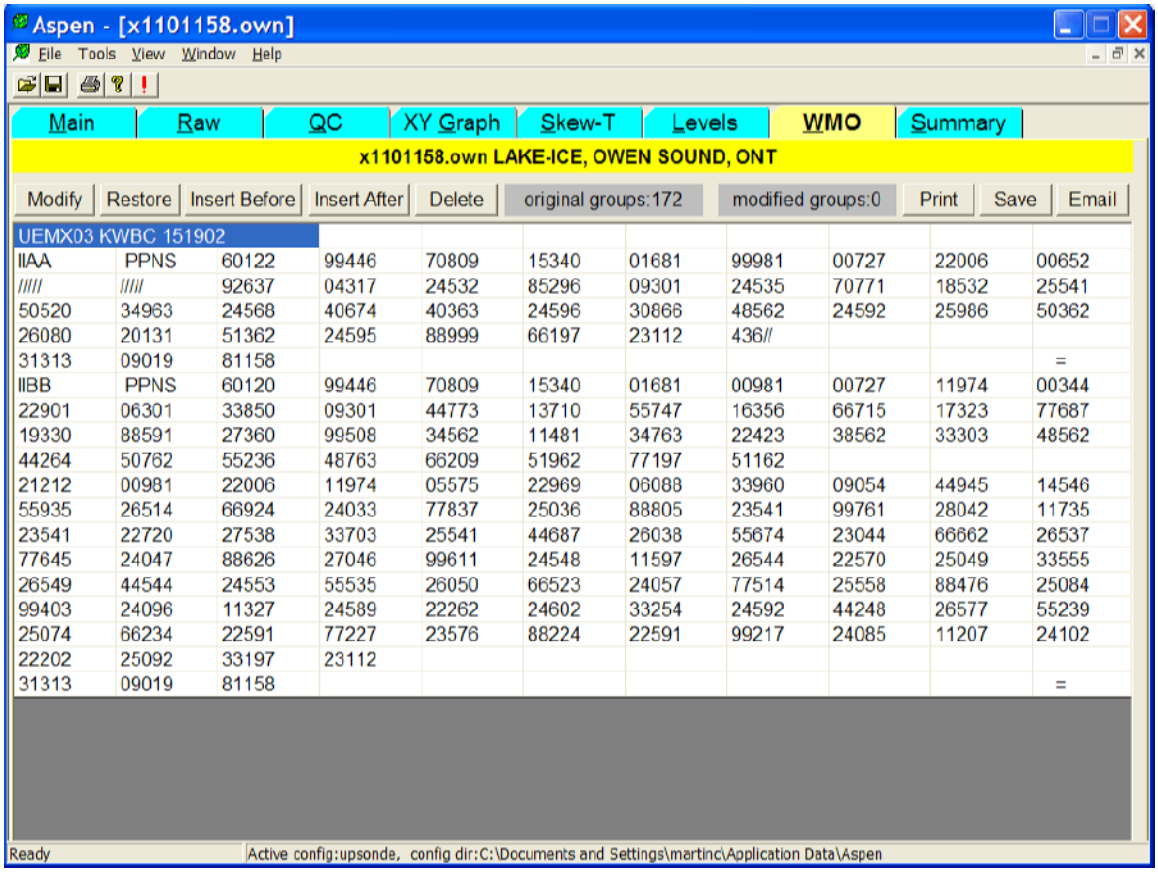
The Levels tab displays the computed levels, which have been derived from the QC data set. The surface and standard levels are highlighted in blue. These are the levels that are coded in parts A and C of the WMO message. The levels data can be previewed and printed from the File menu.

The levels listing may be sorted by any of the variables by clicking on the desired column heading. Clicking a second time in the same heading reverses the order of the sorting. It is typical to sort either by time or pressure, both of which will give similar results.

In certain cases the Aspen operator may wish to prevent particular levels from being coded in the WMO message. Clicking on a level in the Levels Tab will mark a level so that it is not coded. Excluded levels are marked with a red background. Click again on the level to toggle its status back for normal coding.

> *Not all variables are recorded for each level. This is because each level type is used to report only specific variable in the coded message. If a variable is not reported for a given level type, it is not calculated for that level.*

## *WMO Tab*




The WMO tab displays the WMO message, which has been coded from the levels information. It can be previewed and printed from the File menu, and also saved as a text file using the *Save* and *Print* buttons.

The WMO message can be emailed from within Aspen by pressing the *Email* button on this tab. The email recipient is specified by the "TempEmailAddress" configuration parameter. When the *Email* button is pressed, the default Windows mail client (e.g. Outlook or Outlook Express) is started, and the user is presented with an email editing window. If the message is being mailed to an automatic processing system, such as the NWS email GTS ingest gateway, then the mail client should be configured to send in plain text format, and to no wrap the text lines. Group or alias entries can also be made in the client address book (e.g. "GTS") to serve as the message recipient address.

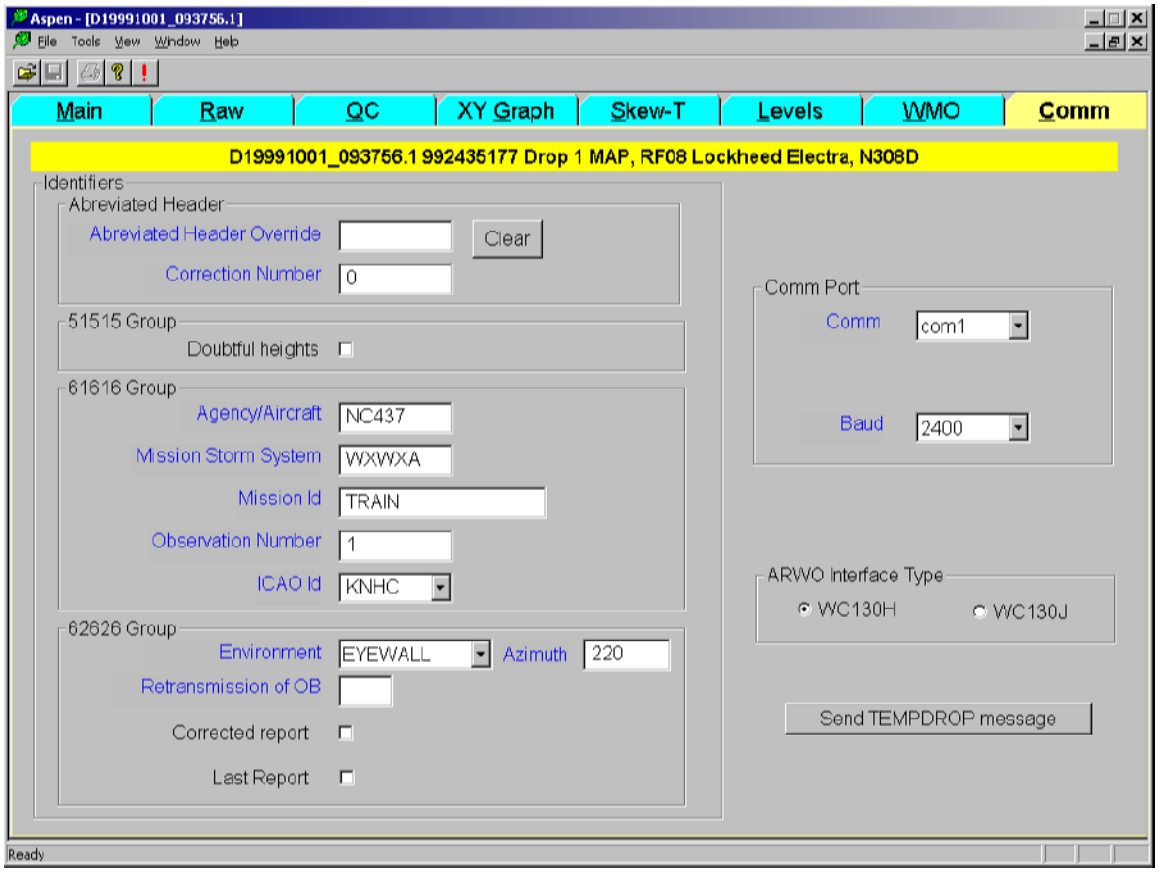
The format for the WMO message is very exacting, and there may be times when Aspen does not get the coding quite right. The buttons at the top left of the WMO tab allow the user to modify the WMO message if necessary. Use the mouse to select the code group to be edited, and press the appropriate editing button.

*Some code groups, such as the abbreviated header, the 61616 group, and the 62626 group contain more than the nominal 5 characters. To select these groups for editing, you must click on the left end of the code group.*

There are a number of administrative entries in the WMO message that are not derived from the levels data. These are items such as the abbreviated header, and information in the 61616 and 62626 groups. This information is managed on the Comm tab. When a field is changed on the Comm tab, the WMO message is adjusted accordingly.

*If the sounding analysis is recomputed (from the Main tab), a new WMO message will be coded, and any edits made previously will be lost.*

## Comm Tab




The Comm tab is used to enter the administrative information that is coded in the WMO message. It also has controls for transmitting the WMO message via an attached interface on the USAFR WC130 aircraft. The field names should be self-explanatory.

Press the "Send TEMPDROP message" button to transmit the WMO message. A message box will pop up to indicate that the transmission is in progress.

*Most of the data entry fields on the Comm tab are saved as soon as they are entered, and used as the defaults for the next sounding that is processed. Be sure to verify that the fields are correct before saving or transmitting the message.*

# Menu Commands

The menu commands will be familiar to anyone who has previously used Windows-based programs. Only the Tools Menu contains commands unique to Aspen.

## *File Menu*

The File menu contains command choices that are generally applicable to all tabs within Aspen. There are cases when a command cannot be used with a particular tab. For instance, when the Main tab is selected, the File Save command is not enabled, since there is no data product associated with this tab. The following commands are found under the File menu:

| | |
|---|---|
| Open… | Open a sounding file and begin the processing. |
| Close | Close the sounding. |
| Configuration. | Open the configuration editor (available only when no soundings are open. |
| Save… | Save data products associated with the tab. |
| Print… | Print the tab. The output print format will depend on the tab type. |
| Print Preview | Preview the print output. |
| Print Setup… | Configure the printer. |

At the bottom of the File menu is a list of the most recently analyzed files. Sometimes it is convenient to go here to reopen a sounding that you have recently examined.

See the **"**Configuration**"** section for an explanation of the configuration management procedures.

## *Tools Menu*

The Tools menu provides access to commands associated with the QC parameters, when a sounding is open. See the **"**Configuration**"** section for their description.

## *View Menu*

The display of toolbar and status lines is controlled in the View menu.

## *Window Menu*

The Window menu contains a listing of all of the soundings currently being analyzed by Aspen. Clicking on the file name will bring that sounding to the front of the display.

## *Toolbar*

The Toolbar provides buttons that can be clicked instead of selecting some of the entries found on the drop-down menus. As with the File menu, the buttons that are enabled depend upon which tab is currently selected.

# Quality Control Procedures

One of the main purposes of Aspen is to apply quality control algorithms to a sounding. These algorithms attempt to systematically detect data points that are likely to be incorrect, and remove them from the QC data set.

The processing begins with a copy of the original (raw) observations. In most cases, all parameters are considered separately. The main exception to this is the handling of the wind observations. In this case, the wind speed and direction are separated into *u* and *v* components, and the QC tests are individually applied. However, if one of the two components fails a test, then both components as well as the speed and direction are removed from the QC data.

There are other QC tests that depend upon the relationship between two variables; in some algorithms, the processing of a given parameter requires input from another parameter. For instance, the GPS-measured velocity is used as a discriminator for the horizontal wind observations. In another case, the dynamic adjustment procedure requires the time constant of the sensor making the measurement. This time constant is a function of density and ventilation rate, which are obtained from the pressure and vertical velocity.

## *The Algorithms*

The following table lists the QC processing steps, in the order that Aspen applies them. Also listed are the sounding direction and variables to which each step is applied. Following the table is a more detailed description of each step.

**Table 1. QC Processing Steps**

| Procedure | | Sounding Direction | | Variable | | | | Note |
|---|---|---|---|---|---|---|---|---|
| | | Dn | Up | P | T | RH | Wind | |
| 1. | Launch parameter overrides | ✓ | ✓ | ✓ | ✓ | ✓ | | a |
| 2. | Copy raw data set to QC data set | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 3. | End of drop override | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 4. | Ambient equilibration | ✓ | | ✓ | ✓ | ✓ | | |
| 5. | Apply fixed offsets | ✓ | ✓ | ✓ | ✓ | ✓ | | |

| Procedure | | Sounding Direction | | Variable | | | | Note |
|---|---|---|---|---|---|---|---|---|
| | | Dn | Up | P | T | RH | Wind | |
| 6. | Limit Check | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 7. | Satellite Check | ✓ | ✓ | | | | ✓ | b |
| 8. | Buddy Check | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 9. | Outlier Check | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 10. | Filter Check | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 11. | Pressure Smoothing | ✓ | ✓ | ✓ | | | | |
| 12. | Monotonic Pressure Check | ✓ | ✓ | ✓ | | | | |
| 13. | Temperature Dynamic Adjustment | ✓ | ✓ | | ✓ | | | |
| 14. | RH Lower Limiting | ✓ | ✓ | | | ✓ | | |
| 15. | Smoothing | ✓ | ✓ | | ✓ | ✓ | ✓ | |
| 16. | RH Lower Limiting | ✓ | ✓ | | | ✓ | | |
| 17. | Pressure Adjustment | ✓ | | ✓ | | | | |
| 18. | Compute Vertical Velocity | ✓ | ✓ | | | | | |
| 19. | Vertical Velocity Check | ✓ | ✓ | | | | ✓ | b |
| 20. | Create Surface Observation | ✓ | | ✓ | ✓ | ✓ | | |
| 21. | Winds Dynamic Adjustment | ✓ | ✓ | | | | ✓ | |
| 22. | Compute Altitude | ✓ | ✓ | | | | | |
| 23. | Compute Position | ✓ | ✓ | | | | | |

| Procedure | Sounding Direction | | Variable | | | | Note |
|---|---|---|---|---|---|---|---|
| | Dn | Up | P | T | RH | Wind | |

Notes: a: Launch parameter override for the winds will be available in a future version
b: GPS based winds only
c: Dependent upon sonde type

A description of each processing step follows. If the step can be adjusted via a configuration parameter, the title for the configuration item is listed, as it appears on the Aspen configuration-editing dialog. See the Configuration section for details on managing Aspen configurations.

*1.* ***Launch parameter overrides*** *Dn Up P T RH*

The user-specified launch parameter overrides, if any, are substituted for the ones given in the data file.

***2. Copy raw data set to QC data set*** *Dn Up P T RH Wind*

The QC data set is initialized with a copy of the original observation. If the option is chosen to discard frames with CRC errors, these frames are not copied to the QC data set, except for the very last frame in the original observation (applies only to AVAPS dropsonde soundings).

***3. End of drop override*** *Dn Up P T RH Wind*

If the user has specified an end of drop time, all data beyond this time is ignored.

***4. Ambient equilibration*** *Dn P T RH Wind*

A dropsonde undergoes an extreme change in environment when exiting the aircraft. The pressure, temperature and RH sensors require a significant time period to get close to the ambient conditions. This equilibration time is calculated to be 7 times the time constant of the sensor, and data within this period is discarded.

The temperature time constant is dependent on the ventilation rate (which is the fall rate), and the air density. Right at the dropsonde launch, the pressure sensor is undergoing extreme changes, and cannot be used to determine the dropsonde fall rate. For this reason, a theoretical fall rate is calculated, which is based on the force balance between the parachute drag and the mass of the sonde. This fall rate has been shown to be reasonably accurate. The aircraft measured temperature and pressure, or the first observed values in the sounding, are used to calculate the density, and the temperature time constant at launch is computed using these parameters.

The ambient equilibration region for pressure is set equal to the temperature region, so that pressure and temperature have the same data coverage at the top of the sounding.

An empirically determined formulation for the RH time constant is used.

***5. Apply fixed offsets*** *Dn Up P T RH*

Fixed offsets can be added to the measurement. *Configuration Item: Offset to Add*

***6. Limit Check*** *Dn Up P T RH Wind*

Absolute bounds checks are used to discard measurements falling outside of hard limits. The limits are set at:

**Table 2. Limit Check Bounds**

| Parameter | Minimum | Maximum |
|---|---|---|
| P | 1 mb | 1200 mb |
| T | -100 °C | 50 °C |
| RH | 0 % | 100 % |
| Wind Speed | 0 m/s | 150 m/s |
| Wind Direction | 0 | 360 |

*7.* ***Satellite Check*** *Dn Up Wind*

GPS-derived winds are not reliable if an insufficient number of satellites are used in their computation. If the number of satellites falls below a minimum, the associated wind observations are discarded. *Configuration item: Number of Satellites*

***8. Buddy Check*** *Dn Up P T RH Wind*

This test uses the data points on either side of an observation to check for consistency, and is useful for detecting and removing wild points. Since the neighboring points may be separated from the observation by varying time deltas, the buddy check thresholds are specified in terms of change per unit time. A point is discarded if it shows a change greater than the limit for one neighbor, and a change greater than the limit, but of the opposite sign, for the other neighbor. *Configuration Item: Buddy Check Slope*

***9. Outlier Check*** *Dn Up P T RH Wind*

A least-squares linear fit to the data series is calculated. Data points that are greater than a specified multiple of the standard deviation from the linear fit are removed from the data set. *Configuration Item: Outlier Check*

***10. Filter Check*** *Dn Up P T RH Wind*

A copy of the data series is low pass filtered at a given wavelength. Data points are removed if they differ from the filtered series by greater than a specified deviation. *Configuration Items: QC Filter Wavelength, QC Filter Deviation*

***11. Pressure Smoothing*** *Dn Up P*

The final smoothing is applied to the pressure data. The pressure needs to be smoothed before the pressure monotonic check. *Configuration Item: Final Smoothing*

***12. Monotonic Pressure Check*** *Dn Up P*

The pressure trace must change monotonically in order for pressure-based searching to be performed. The pressure time series is scanned; when a point is found which follows an incorrect trend (i.e. decreasing for a dropsonde, increasing otherwise), it is removed from the series.

***13. Temperature Dynamic Adjustment*** *Dn T*

The temperature is adjusted for the time lag related to the sensor time constant. The time constant is a function of the sonde ascent rate and the density. An empirically determined relation for the sensor time constant, as a function of pressure and ascent rate, is used.

The series is first smoothed using the temperature dynamic correction smoothing wavelength. This smoothed series is used to compute a time tendency for each data point. Each observation is then adjusted by adding to it the product of the time constant and tendency. *Configuration items: Dynamic Correction On-Off and Dynamic Correction Wavelength*

***14. RH Lower Limiting*** *Dn Up RH*

RH values less than 0.2% are set to 0.2%.

***15. Smoothing*** *Dn Up T RH Wind*

The series are smoothed using the final smoothing wavelength. *Configuration Item: Final Smoothing*

***16. RH Lower Limiting*** *Dn Up RH*

RH values less than 0.2% are set to 0.2%.

***17. Pressure Adjustment*** *Dn P*

If a surface pressure is specified on the main tab, it is proportionally applied to the pressure profile as a function of time. Thus the bottom pressure value becomes the specified pressure, and the launch pressure is unchanged, with a proportional adjustment applied between these points.

***18. Compute Vertical Velocity*** *Dn Up P*

The pressure series is first smoothed using the final pressure-smoothing wavelength. The time tendency of the pressure is then computed at each data point. The time-differentiated hydrostatic equation is then used to compute the vertical velocity.

***19. Vertical Velocity Check*** *Dn Up Wind*

The GPS-measured fall velocity is a good discriminator for the quality of the GPS-derived horizontal wind. If the difference between the hydrostatically determined fall velocity and the GPS-measured velocity is greater than the specified limit, the horizontal wind point is discarded. *Configuration item: Vertical Velocity Threshold*

***20. Create Surface Observation*** *Dn P T RH*

In order to achieve as accurate a surface pressure reading as possible, a procedure is applied which attempts to account for the distance the dropsonde fell to the surface after the last data point was reported. Empirical estimates of this distance are used to extrapolate the last surface pressure measurement to the surface. The last temperature and RH are simply duplicated for the surface measurement, since the distance is generally on the order of 5 meters. These fabricated measurements of pressure, temperature and RH are appended to the data series.

***21. Winds Dynamic Adjustment*** *Dn Up Wind*

Each wind component is adjusted with the formula: $u_{new} = u_{obs}$ - (du/dt)*(dz/dt)/g. The wind component series is first smoothed, using the winds dynamic correction smoothing wavelength for the component. This smoothed series is used to compute a time tendency for each data point. The observation is then adjusted according to the formula, using the previously calculated vertical velocity for dz/dt. *Configuration items: Dynamic Adjustment On-Off and Dynamic Correction Wavelength*

***22. Compute Altitude*** *Dn Up*

The hydrostatic equation is integrated from the surface upwards. For dropsondes, the same computation may be made from the launch altitude downward. See the **Post-Processing Adjustment** section for a description of dropsonde height computations.

The downward height integration requires both a starting altitude and a starting pressure. If the pressure at launch time for a dropsonde is not available (a common situation on many aircraft), the first raw pressure point from the dropsonde is used as the launch pressure, but only for the purpose of height computation. This unwarranted assumption can lead to significant height errors if the raw sonde pressure data is late or inaccurate.

***23. Compute Position*** *Dn Up*

The horizontal winds are used to integrate the sonde location from the initial launch position. If a time gap of greater than maximum position integration interval (a configuration parameter) occurs in the wind measurements, the integration terminates.

The position integration requires an initial position to start the integration. Similarly, an initial wind speed and direction at the launch point are used in the integration. If these are not available, Aspen will use the first Q/C wind speed and direction as the launch point value. This unjustified assumption thus assumes a constant wind profile at launch, in the absence of a wind measurement at the launch point. *Configuration Item: Position Interpolation*

## *Guidelines for Adjusting QC Parameters*

The supplied default values for the Aspen Q/C parameters in general produce excellent results. However, there may be times when a group of soundings have peculiar error characteristics, and the Q/C paramaters need to be modified in order to produce better discrimnation against outliers. Some tips for adjusting the configuration parameters are given here. The user should carefully read and understand the descriptions of the Q/C

algorithms given in the preceeding section; this will provide the best guidance on modifying the Q/C parameters to match the error characteristics of the sounding data.

- Toggle the display of raw data off and on in order to see which data points are being rejected by the algorithms. Toggle the "mark points" option, and use the zoom and pan capabilities freely to investigate the effectiveness of the procedures. Stay zoomed in on a region when modifying configuration parameters, and use the "!" (recompute) button to reprocess the sounding, so that the new results are displayed immediately in the zoomed region.
- If the sounding system does not report the number of GPS satelittes used in the winds calculation, set the GPS satellite threshold to 0, so that winds are not discarded due to a lack of satellites.
- The most frequently adjusted parameters are the the *QC Filter Wavelength* and the *QC Filter Deviation,* which are used in the filter check and are applied together. In this algorithm, a smoothed curve is calculated from the data series. If the filter wavelength is small, the curve will closely follow the data; if large the curve will be a very smooth representation of the data. The deviation is the amount that a data point is allowed to deviate from the smoothed curve. If the difference between the curve and the raw data point is larger than the deviation, the data point is discarded. The interplay between the amount of smoothing and the allowed deviation allow for wide latitiude in tuning the filter check algorithm.
- The dynamic adjustments for temperature and wind speed can significantly increase the variance of the data series. If the Q/C results appear noiser than the raw data, it will be due to the dynamic adjustments. Use of the dynamic adjustments is the perogative of the user, and can be deactivated in the configuration. Note that the tendency of the series, used in the adjustment, is calculated from a smoothed version of the data. The final smoothing wavelength is used for the smoothing value during the dynamic adjustment procedure. If a very small smoothing wavelength is specified, the variance increase in the Q/C data can become significant.

# Configuration

Aspen is very flexible and can produce a large variety of output products. It will analyze data from a number of different sounding systems. In order to tailor it for differing applications, Aspen provides a configuration system. This same system is used to configure Aspen, BatchAspen and AspenQC, and the configuration information is shared between each of these programs.

**Configuration Items:** At the heart of the configuration system is the *configuration item*, which matches a keyword with a current value, and a default value. The keyword identifies a particular characteristic to be used during the next Aspen analysis; e.g. the smoothing wavelength to be applied the pressure field, or the mass of the dropsonde.

**Configuration sets:** A family of configuration items is collected in a *configuration set*. Configuration sets are assigned names, and a named set is chosen as the currently active one, to be used the next time that Aspen is run. In this way, users can create configuration sets that are tailored to a particular instrument, environment, or field program, and switch between them as needed.

**The Active Set:** At any time, one of the named configuration sets is designated as the active set. This means that any further processing with Aspen or BatchAspen will use the configuration items from the active set. **It is critical that the user verify that the correct set has been designated as active when processing soundings.**

A user interface is provided within Aspen and BatchAspen for manipulating the Aspen configuration. This is divided into two activities. The first is the management of the configuration sets: creating, deleting and activating a set. The second is modification of the configuration items within a selected set.

Note that within Aspen, the management of the configuration sets can only be initiated from the File menu, when no soundings are currently open. Configuration items for any named set may be modified at this time also. However, configuration items for the currently active set may also be modified when soundings are open within Aspen.

**aspen.xml:** The configuration information is stored in XML[1] format, in a file named *aspen.xml*. A "Document Type Definition file", *aspen.dtd*, accompanies aspen.xml, and must be located in the same directory. See the Appendix A: Configuration Parameters, for a description of aspen.xml.

The location of these files depends upon the version of Windows, as well as the *ASPENCONFIG* environment variable. When Aspen first runs, it checks to see if *ASPENCONFIG* is set. If it is, Aspen then checks for the existence of the configuration

[1] XML: Extensible Markup Language; this is a widely used standard for defining structured data, and is used extensively in Web applications.

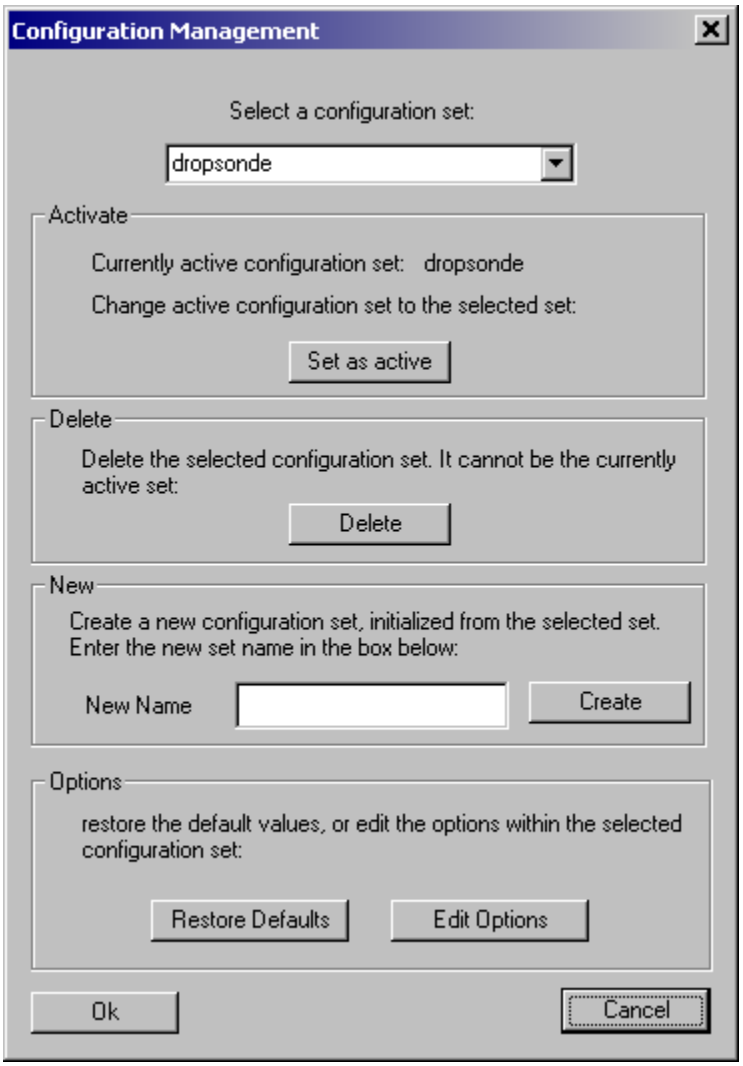
files in that directory. If the files are not found, Aspen offers to copy default configuration files to that directory.

If *ASPENCONFIG* is not set, Aspen will assume directories for the configuration files, according to the following:

- For Windows 98 systems: The directory where Aspen is installed
- For Windows NT/2000/XP systems: C:\Documents and Settings\<user name>\Application Data\Aspen\. This scheme allows individual users to maintain private versions of the configuration files.

## *Configuration Set Management*

Management of the configuration sets is available through the File->Configure… menu within Aspen and BatchAspen. Choosing this item will cause a configuration set management dialog to open, from which configuration sets may be activated, deleted, created and edited:


Configuration Management
Select a configuration set:
dropsonde
Activate
Currently active configuration set: dropsonde
Change active configuration set to the selected set:
Set as active
Delete
Delete the selected configuration set. It cannot be the currently active set:
Delete
New
Create a new configuration set, initialized from the selected set. Enter the new set name in the box below:
New Name
Create
Options
restore the default values, or edit the options within the selected configuration set:
Restore Defaults
Edit Options
Ok
Cancel

The selection drop down box at the top of the dialog is used to select the named configuration set that all other operations will reference. The selected set can be activated, deleted, or edited using other buttons in the dialog. To create a new configuration set, select an existing set to be used a source set, enter a name in the box, and hit the Create button.

When all configuration editing actions are finished, hit the Ok button to save them, or the Cancel button to discard the changes.

The actual configuration items for the selected configuration set can be edited by hitting the Edit button. This will bring up a dialog from which the quality control parameters and other options can be modified. See the "Changing the QC Parameters" section (below) for details on modifying the configuration items from this dialog.

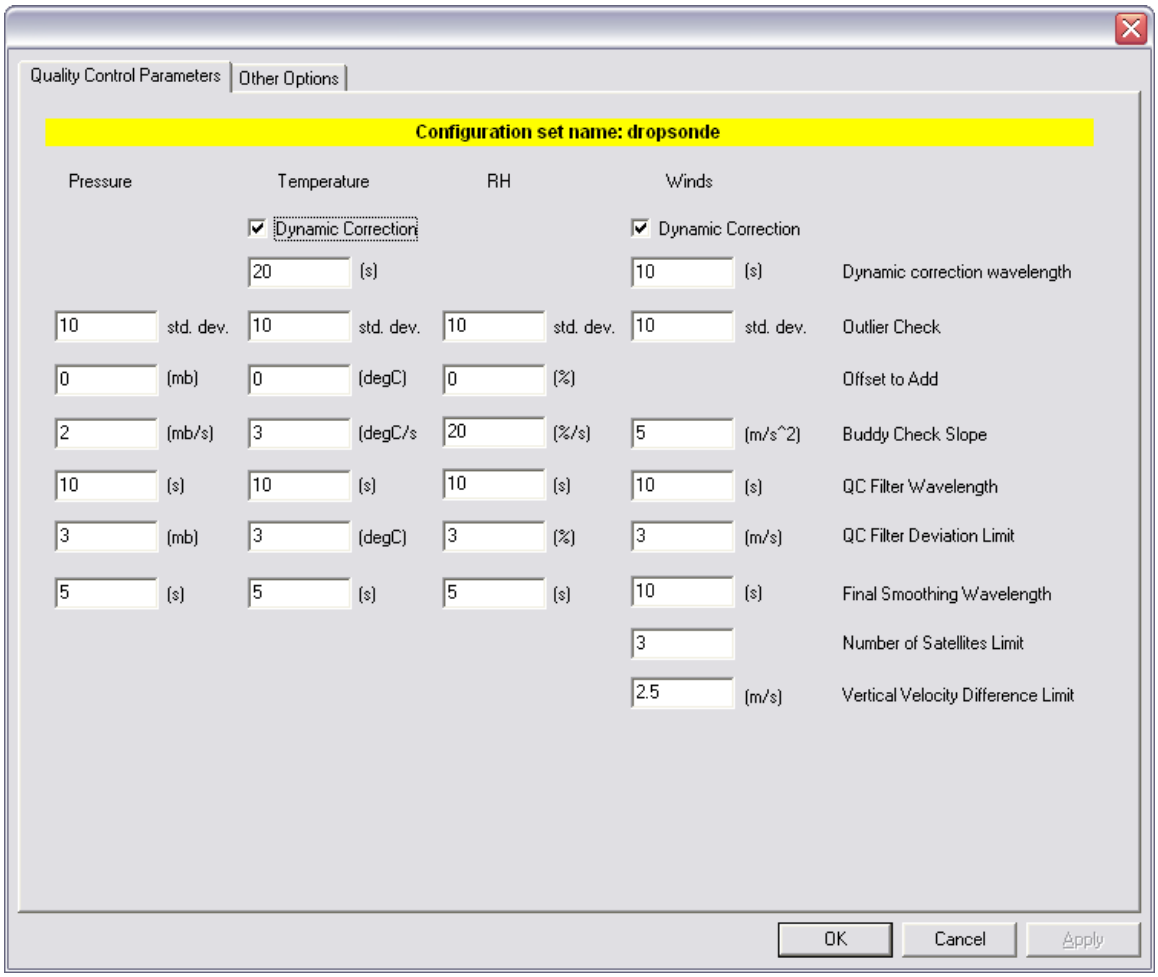
Hitting the Restore Defaults button will restore the entire set of configuration items for the selected set, restoring them to their default values.

**The Sample Configuration Set:** There is a special configuration set, named *sample*, provided with Aspen. This set cannot be activated, deleted or edited. It is available as a default set that can be used as the source when creating a new configuration set.

> *Remember that within Aspen, the configuration editor is only available (from the File->Cofigure… menu) when no soundings are open. When soundings are open in Aspen, the options for the currently active configuration set can be edited from the Tools->Options menu.*

### *Changing the QC Parameters*

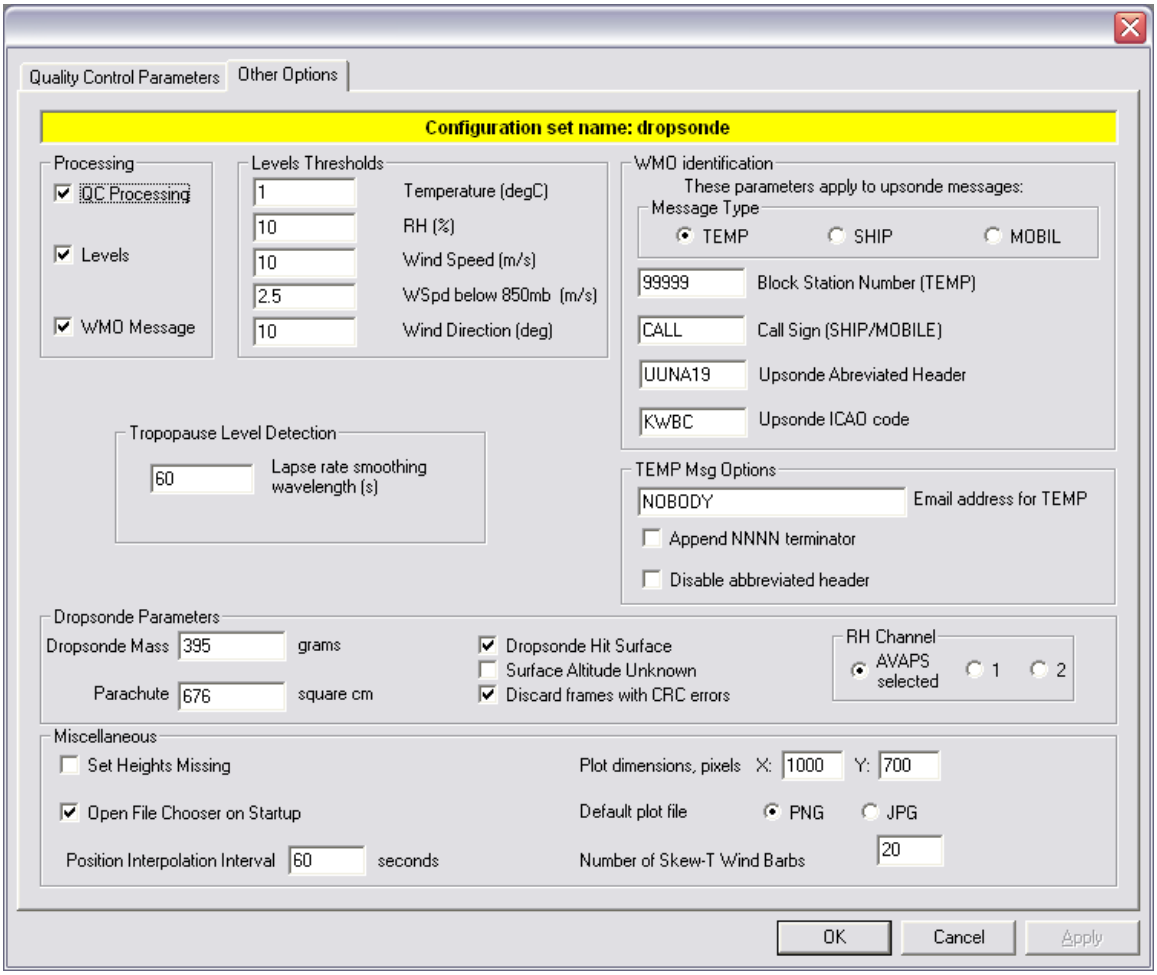
In order to configure Aspen to match your particular requirements, the configuration items (i.e. parameters) within a configuration set must be properly specified. This can be initiated from either the configuration management menu (File->Configure…->Edit Options) when no files are open, or from the options menu (Tools->Options…). A tabbed property sheet will open, containing two tabs. The "Quality Control Parameters" tab is used to configure quality control parameters:




The quality control parameters are used to adjust the various quality control algorithms, and are described in the "Quality Control Procedures" section.

### *Other Options*

The "Other Options" tab provides further options for the processing of sounding data:




**QC Processing.** In normal usage, this feature should always be enabled. If it is turned off, Aspen will only display the raw sounding data. This may be useful if you want a quick look at a large data set without waiting for processing.

**Levels – WMO message.** These two features should always be enabled if WMO messages are the ultimate data product (e.g. weather reconnaissance). For all other soundings, these features may be turned off.

**Levels Thresholds.** These five parameters set the thresholds used in the determination of the GDL levels for the designated measurement. They should be modified with caution, since this would result in a deviation from the specifications of the FMH-3.

**Tropopause Level Detection: Lapse Rate Smoothing Wavelength**. This is the wavelength of the smoother that will be applied to the temperature data before the automatic determination of tropopause levels is made. A tropopause is identified by the derivative of the temperature lapse rate, and so a high variance in temperature can lead to the creation of unrealistic tropopause levels.

**WMO Message Type.** Choose the type of TEMP message to be generated for an **upsonde** sounding.

**Block Station Number and Call Sign.** These are identifiers that are required either for the TEMP, TEMPSHIP, or TEMPMOBILE messages.

**Upsonde Abbreviated Header.** The WMO abbreviated header for upsonde WMO messages. (Note that dropsonde abbreviated headers are specified on the Comm tab).

**Upsonde ICAO Code.** ICAO code for upsonde abbreviated headers. (Note that dropsonde ICAO codes are specified on the Comm tab).

**Email address for TEMP.** Address to receive an emailed WMO message.

**Append NNNN Terminator.** If checked, append NNNN to the WMO message when it is saved or emailed. Some communications systems, such as the GTS, require this terminator.

**Disable Abbreviated Header.** If checked, the abbreviated header will not be generated for the WMO message. This is useful in the common situation where another system generates the abbreviated header.

**Dropsonde Mass and Parachute Area.** The dropsonde mass and parachute area are required in order to estimate the initial fall speed of the dropsonde, after launch from the aircraft. The values differ only from the defaults in special cases where a custom parachute or modified sonde are deployed.

**Dropsonde Hit Surface.** This box is checked if the dropsonde was believed to have hit the surface. This causes the sounding altitudes to be integrated from the surface altitude upwards; otherwise they will be integrated from the flight level altitude (if available) downward. If checked it also allows the computation of an extrapolated surface data point.

**Surface Altitude Unknown.** Check this box if the dropsonde was believed to have hit the surface, but the surface altitude is unknown, as in a dropsonde landing on the earth. It causes the height integration to be performed from flight level down.

**Discard frames with CRC errors.** If this box is checked, data frames that are marked as having a CRC error are discarded. This only applies to AVAPS dropsonde soundings.

**RH Channel**. The AVAPS/Dropsonde based systems use a radiosonde that carries dual relative humidity sensors. The firmware in the sonde chooses the humidity value from one of them, and the selected channel is reported in the main RH field of the "D" file. The original values for both sensors are reported in additional columns in the file. The user can elect to use the sonde chosen value (AVAPS selected), or either of the original sensor values (RH1 or RH2).

**Set Heights Missing.** Check this box to cause the height computations to be skipped, in cases where the operator does not trust the data to provide for accurate height integration.

**Open File Chooser on Startup.** If this box is checked, a File Chooser dialog will open as soon as aspen is started. Otherwise, the File menu can be accessed in order to select a file to process.

**Position Interpolation Interval.** Set the maximum time interval over which the winds can be interpolated for the position integration calculation. If the gap in winds is greater than this interval, the winds will not be interpolated and the position integration will stop.

**Plot dimensions, pixels.** Specify the X and Y dimensions, in pixels, for graphics output files.

**Default plot file.** Choose either PNG or JPG as the default choice for the output graphics file format. The user can also choose the file type at save time. PNG is the recommended format.

### *Saving Changes and Restoring Defaults*

When the user closes a sounding in which the QC parameters have been changed, a dialog box asks if these parameters should be saved as the processing defaults. All soundings opened after this time will be processed using these options. The Tools menu provides a command, Tools⇑Restore Defaults, which can be used to restore the options to initial system defaults. Thus the customized parameters will revert to the initial installation defaults.

The user may also revert the QC parameters to the initial installation defaults before opening any soundings. This is done via the File Configure…Restore Defaults button (available only when no soundings have been opened).

*When in doubt about the proper values of the QC parameters, restore the defaults.*

## Corrupted Configurations

As mentioned above, the configuration information is stored in the *aspen.xml* file. If the configuration file becomes corrupted, Aspen will not be able to run, and the file will need to be repaired or restored.

The file "*AspenOriginal.xml*" is provided as a copy of the orginally distributed configuration file, and is located in the Aspen installation directory (typically "c:/Program Files/ NCAR/Aspen". In the worst case, this file can simply be copied over *aspen.xml* (note that the file name case is significant). This will restore Aspen to the default configuration parameters, but all changes or additions that have been made to the configuration will be lost.

If the *aspen.xml* file is only slightly corrupted, it may be possible to correct the error with a text editor. A simple way to locate a syntax error is to open *aspen.xml* in Internet Explorer, which provides structured viewing of XML files. Internet Explorer will indicate lines that do not parse correctly, and then a standard text editor may be used to fix minor problems.

# BatchAspen

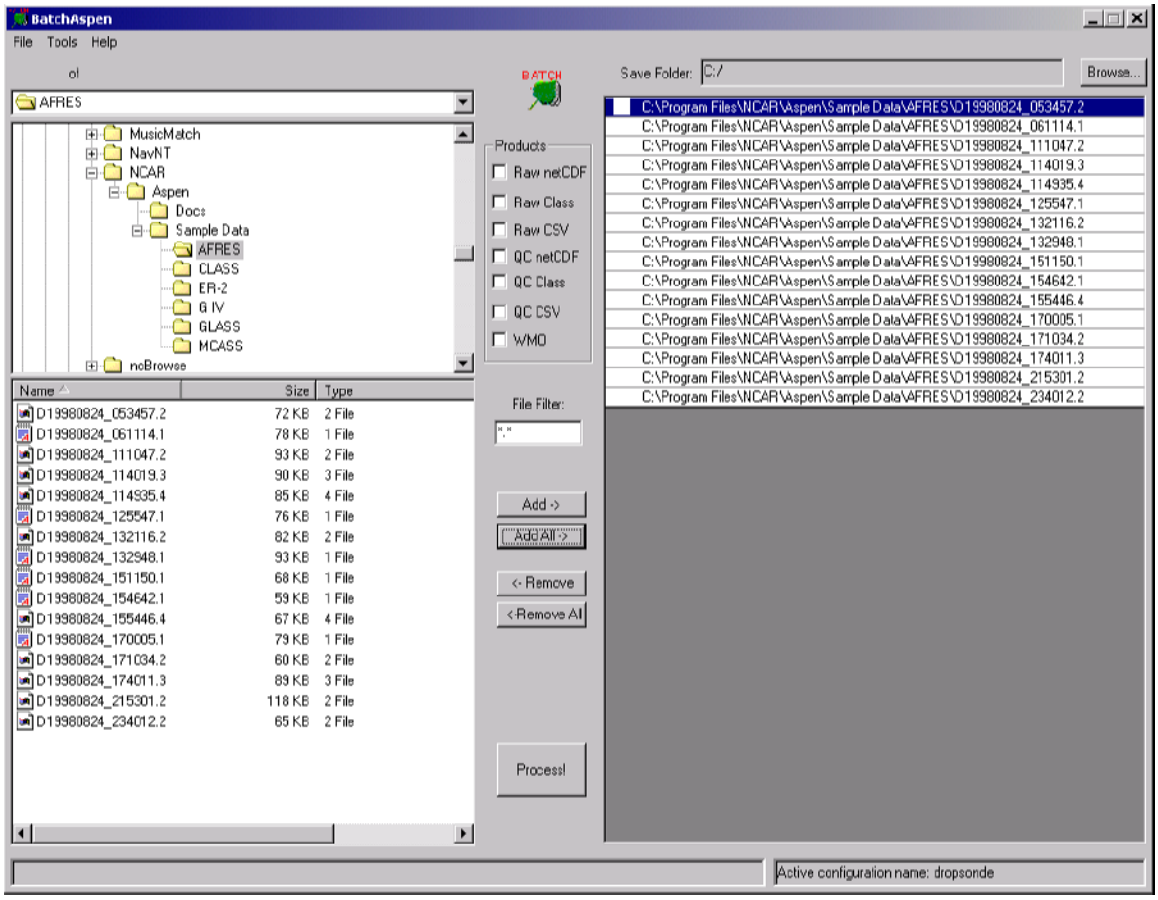
BatchAspen is a separate application that is used to apply the Aspen Q/C procedures to a collection of sounding files. The user selects the data products to be created. The program then iterates over the list of files, placing the results in a specified destination directory.

BatchAspen shares an exact copy of the Q/C processing algorithms that are used by Aspen, so that identical results for both programs can be guaranteed.

## *Starting BatchAspen and Selecting Files*

Start the application by clicking on the BatchAspen icon

. A single screen will be presented. The screen is roughly divided into left and right sections, with control buttons in between. The left side is used to select the files to be processed. The right side specifies the output file destination and the processing list:



On the left side, there are two independent directory browsers, either of which can be used to navigate into directories containing input files. The files in the selected directory are shown in the file selector in the lower left. The display of file types can be restricted using the "File Filter" in the center edit box.

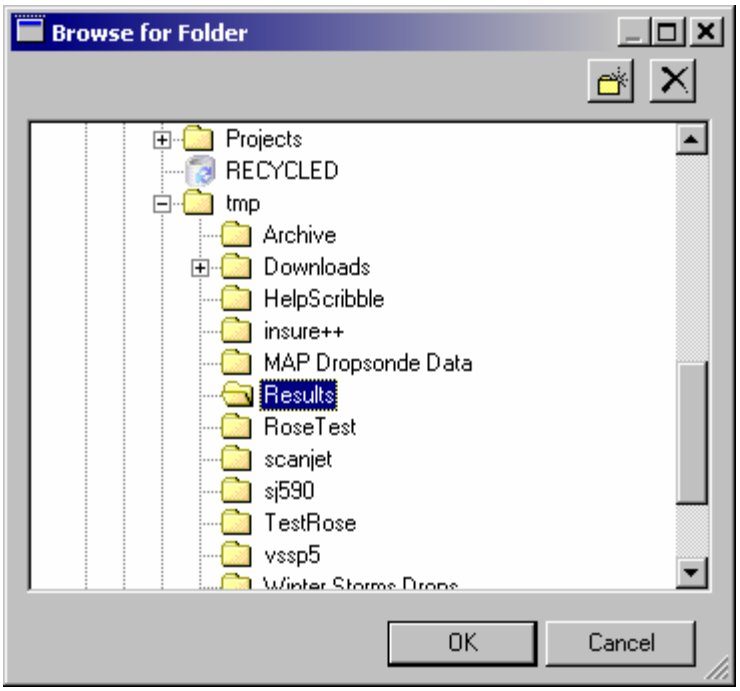
Individual files can be selected, using the standard Explorer left-click, shift-left-click, and ctrl-left-click mouse selection commands. Once the desired files are chosen, press the "Add->" button to add them to the processing list on the right side of the screen. Pressing "Add All->" will cause all of the displayed files to be added to the processing list.

Selected files can also be dragged from the file selector and dropped into the processing list.

*Files from multiple directories can be collected in a single processing list. However, all output files will be created in a single directory.*

Files may be removed from the processing list by selecting them in the processing list, and pressing the "<-Remove" button, or press "<-Remove All" in order to empty the list completely.

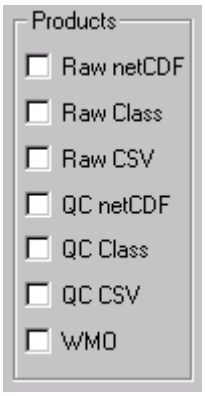
To select the output directory, hit the "Browse" button above the processing list. A folder browser will pop up; use it to select the folder for the output files.




Create a new folder by pressing the "new folder" button.

## *Q/C Processing*

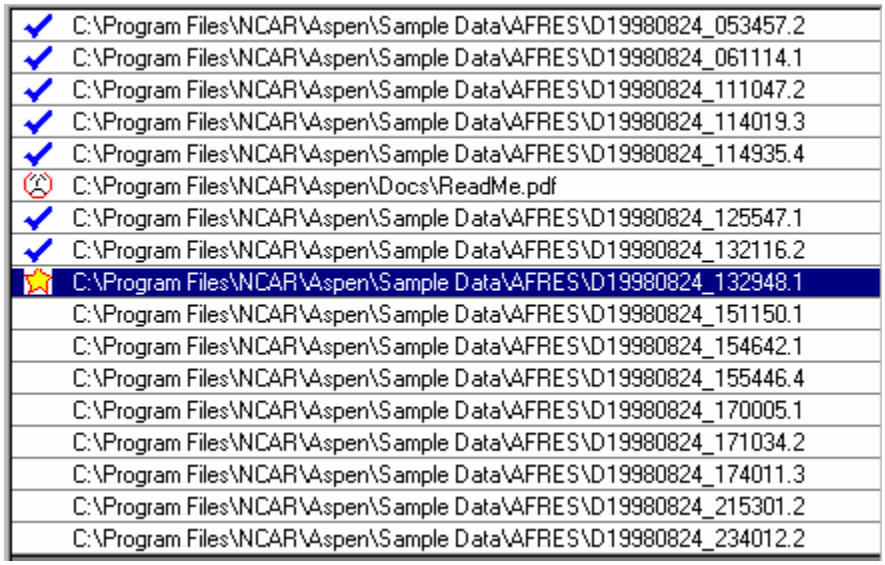
The desired output products are chosen using the toggles:




An output file of each selected type will be created for each input file.

To begin the processing, hit the

button. BatchAspen will start processing each file, starting at the beginning of the list. A status indicator will appear next to each file, with a yellow star denoting the file currently being processed. A check mark indicates that the file was successfully processed; an unhappy face denotes a file that could not be processed.




During the processing of each file, the status box at the top of BatchAspen provides a running display of the Q/C processing steps.

When processing is underway, the "Process" button changes to

. To stop the processing before the end of the list has been reached, press Abort. BatchAspen will stop when the processing of the current file has completed[2].

## *Q/C Parameters*

BatchAspen uses the same configuration scheme as Aspen, which is documented fully in the "Configuration" section. As with Aspen, activating the File->Configure… menu item will display the configuration management interface.

> *The configuration set that is designated as active is used by both Aspen and BatchAspen.*

[2] This may take up to several minutes on a slow machine.

# AspenQC

*AspenQC* is a version of Aspen that performs the Q/C and message coding functions, but does not provide a graphical user interface. Therefore, it can be run from shell scripts or the comand line, to process a sounding data file in a standalone mode. The same Q/C and coding algorithms used in Aspen are incorporated into AspenQC.

A Windows executable file, *AspenQC.exe,* is provided in the Aspen Windows distribution. AspenQC can be compiled and run under Linux. Contact NCAR in order to obtain the source code for Linux.

AspenQC uses the same XML configuration file as Aspen, located in the ASPENHOME directory.

## *Switches*

Command line switches control the processing and output products from AspenQC:

```
usage: AspenQC [-i|--input <sounding file>]
               [-e|--csv [<output csv file>]]
               [-c|--class [<output class file>]]
               [-w|--wmo [<output wmo file>]]
               [-n|--netcdf <output netcdf file>]
               [-v|--verbose]
               [-s|config <config set name>]
               [-a|--csvattributes] [-h|--help]
```

- *i* – the name of the input data file. AspenQC will automatically determine the file type, and as with Aspen, will make assumptions about the type of souding, dependent on the file format. AVAPS, CLASS, GLASS, MCASS and CSV format files can be processed. If this parameter is missing, the data are read from standard input.
- *e* – Generate a CSV format output file ("-e" is meant to indicate *E*xcel, since CSV files are the best method for transfering data between AspenQC and Excel).
- *c* – Generate a CLASS format output file.
- *n* – Generate a netCDF format output file.
- *w* – Generate a WMO message.
- *v* – Print (verbose) status messages as the processing proceeds.

- *s* – Specify a config set name to override the one selected by the <active> tag in the XML configuration file.
- *e* – If a CSV file is being created, print the configuration attributes at the beginning of the file.
  Note that these will not be interpreted or used when a CSV file is used as input to AspenQC.
- *h* – Print out the usage statement.

The output format specifiers (*-e, -c, -w and –n)* can take an optional file name, to which the data will be written. If not provided, the data will be written to the standard output.

An example of an AspenQC usage would be:

```
AspenQC –i classData.dat –a –e classData.csv
```

## Input File Types

Aspen can process sounding data that is provided in the following file formats:

- NCAR AVAPS GPS Dropsonde "D" files
- NCAR GLASS Upsonde files
- NCAR GAUS Upsonde files
- NCAR CLASS Upsonde files
- NCAR MCASS Upsonde files
- "Comma Separated Values" (CSV) (MS Excel compatible)[3]

  *Warning: Aspen automatically detects the format of the file that it opens, and assumes that the sounding contained is from the associated instrument. This can lead to ambiguities, if Aspen is used to process a file that it has written. For instance, if dropsonde data are saved by Aspen in "CLASS" format, and then this file is used as input to Aspen, the program will assume that the data are from an upsonde sounding, rather than a dropsonde. This can lead to erroneous results within Aspen, since the characteristics of the sounding system affect the processing procedures.*

Output files can be produced for data products in the following formats:

**Table 3. Output File Types**

| Data Product | File Output Formats |
|---|---|
| Raw data | NetCDF<br>CSV<br>NCAR CLASS format ASCII text<br>NCAR EOL format ASCII text |
| QC data | NetCDF<br>CSV<br>NCAR CLASS format ASCII text<br>NCAR EOL format ASCII text |
| Graphics | JPG<br>PNG |

[3] See Comma Separated Values (CSV) on page 48 for a more general description of Aspen compatible CSV files.

| Data Product | File Output Formats |
|---|---|
| | (or use Alt-PrtSc for clipboard capture) |
| Levels | None |
| WMO message | ASCII text |

# Appendix A: Configuration Parameters

The Aspen configuration is stored in XML format. There are two files: *aspen.xml* and *aspen.dtd*. *aspen.xml* contains the actual configuration values, while *aspen.dtd* defines the syntax of the *aspen.xml* file.

Explanation of the structure of XML files is beyond the scope of this manual. However, given an existing XML file, it is not difficult to discern the layout of the information[4]. XML elements are delineated by start and end tags, and are nested to create a hierarchical data structure. *aspen.xml* observes the following structure:

```
<aspenConfig>
      <active>dropsonde</active>
      <set name="sample">
            <option name="SetHtsMissing" type="bool">
                  <current>false</current>
                  <default>false</default>
            </option>
            .
            .
            .
            <option name="WindSmoothWL" type="numeric">
                  <current>10.000000</current>
                  <default>10.0</default>
            </option>
            <option immediate="true" name="IcaoIndex" type="numeric">

                  <current>1.000000</current>

                  <default>1</default>

            </option>
      </set>
      <set name="dropsonde">
      .
      .
      .
      </set>
</aspenConfig>
```

Thus, the Aspen configuration contains one entry (<*active*>), designating which named configuration set is active, followed by one or more named configuration sets (<*set*>).

[4] This is particularly easy if the the file is examined with an XML capable browser, such as Internet Explorer.

Each configuration set contains a list of configuration options (<*option*>), with the current and default values for each option. Each option has a designated type:

- *bool* – boolean, with a value of either true or false.
- *numeric* – A floating point numeric value.
- *string* – A text string.

An option may also be marked with "*immediate=true*" to effect an immediate save of the option when it is changed. It is useful for some options to be saved immediately after they are changed, before closing the sounding in Aspen, so that when the next sounding is analyzed, it will immediately use the new version of the option. For instance, if the dropsonde operator on the Hurricane Hunter aircraft opens a sounding, and then changes the ICAO value for the TEMP message, it is likely that all soundings opened during the same run of Aspen should use this value for the ICAO string. An immediate save allows the configuration to be updated, without having to close that sounding.

The following table gives a description of the configuration options.

> *The case of the configuration item name is critical. It must be matched exactly as shown.*

| Element name | Type | Description |
|---|---|---|
| SetHtsMissing | bool | Corresponds to the "Set heights missing" checkbox on the main tab, which causes height computations to be skipped. |
| DropsondeHitSfc | bool | Corresponds to the "Dropsonde Hit Surface" checkbox on the main tab, indicationg that the dropsonde sounding terminated with hitting the surface. |
| SfcAltUnknown | bool | Corresponds to the "Surface Altitude Unknown" checkbox on the main tab, which when set causes the upward height computation to be skipped. |
| DiscardBadCrcData | bool | Set true if frames with CRC errors are to be discarded. (AVAPS dropsondes only). |
| ReportObservedPos | bool | If true, the sonde position reported in the input file will be used in place of the winds integrated position. Lat and Lon from the input file will go directly into output products and the tabular displays. This can be utilized to take advantage of sondes which report GPS positions directly. The default is false. |
| WindSmoothWL | numeric | Final smoothing wavelength. |
| WindQCWL | numeric | Filter check smoothing wavelength. |

| Element name | Type | Description |
|---|---|---|
| WindDynCor | bool | Enable dynamic correction. |
| WindDynCorWL | numeric | The wavelength used when smoothing the wind data prior to calculating the derivative used in the dynamic correction. |
| WindBuddySlope | numeric | Buddy check slope limit. |
| WindQCDev | numeric | Filter check deviation limit. |
| WindOutlier | numeric | Outlier check number of standard dev. limit. |
| WindSats | numeric | Minimum number of GPS satellites required in wind solution. |
| WindVVdelta | numeric | Vertical velocity check limit. |
| PresSmoothWL | numeric | Final smoothing wavelength. |
| PresQCWL | numeric | Filter check smoothing wavelength. |
| PresBuddySlope | numeric | Buddy check slope limit. |
| PresQCDev | numeric | Filter check deviation limit. |
| PresOutlier | numeric | Outlier check number of standard dev. limit. |
| PresOffset | numeric | Offset correction. |
| TdryQCWL | numeric | Filter check smoothing wavelength. |
| TdryDynCor | bool | Enable dynamic correction. |
| TdryDynCorWL | numeric | The wavelength used when smoothing the temperature data prior to calculating the derivative used in the dynamic correction. |
| TdryQCDev | numeric | Filter check deviation limit. |
| TdryOutlier | numeric | Outlier check number of standard dev. limit. |
| TdryOffset | numeric | Offset correction. |
| TdryBuddySlope | numeric | Buddy check slope limit. |
| TdrySmoothWL | numeric | Final smoothing wavelength. |
| RHSmoothWL | numeric | Final smoothing wavelength. |
| RHQCWL | numeric | Filter check smoothing wavelength. |

| Element name | Type | Description |
|---|---|---|
| RHBuddySlope | numeric | Buddy check slope limit. |
| RHQCDev | numeric | Filter check deviation limit. |
| RHOutlier | numeric | Outlier check number of standard dev. limit. |
| RHOffset | numeric | Offset correction. |
| TdryLevelDelta | numeric | Threshold value for GDL determination on temperature. |
| RHLevelDelta | numeric | Threshold value for GDL determination on RH. |
| WspdLevelDelta | numeric | Threshold value for GDL determination on wind speed. |
| Wspd850LevelDelta | numeric | Threshold value for GDL determination on windspeed, below 850 mb. Applies only to dropsondes. |
| WdirLevelDelta | numeric | Threshold value for GDL determination on wind direction. |
| TropSmoothWL | numeric | The wavelength used for smoothing of the temperature time series before calculation of tropopause levels. |
| DoQC | bool | True to perform quality control processing. |
| DoLevels | bool | True to calculate levels. |
| DoWMO | bool | True to create the coded message. |
| AutoFile | bool | True to enable of file chooser when aspen starts. |
| ChuteArea | numeric | Dropsonde parachute cross section area , $cm^2$. |
| DropSondeMass | numeric | Dropsonde mass, grams. |
| PosInterpSpan | numeric | Maximum time span, in seconds, over which the position integration will be interpolated. |
| CallSign | string | Immediate, call sign for TEMPSHIP and TEMPMOBIL messages. |
| BSN | string | Immediate, Block Station Number for TEMP messages. |

| Element name | Type | Description |
|---|---|---|
| TempMsgType | numeric | Temp message type (0=TEMP, 1=TEMPSHIP, 2=TEMPMOBIL) |
| TempApendNNNN | Bool | Set true if an NNNN should be appended to the TEMP message when it is saved in a file. This terminator is required by some telecommunication gateways. |
| RHchoice | numeric | AVAPS RH channel selection(0=AVAPS selected, 1=RH1, 2=RH2) |
| ExcludeAbrHdr | bool | True if the abreviated header should be excluded from the TEMPDROP message. |
| PlotPixelsX | numeric | Default plot X dimension in pixels. |
| PlotPixelsY | numeric | Default plot Y dimension in pixels. |
| PlotFileFormat | numeric | Default graphics file output format (0=PNG, 1=JPG) |
| ACtype | numeric | Immediate, Dropsonde aircraft type (0=C130H, 1=C130J). Use only for the automated file transfer method for Huricane Hunters. |
| BaudRateIndex | numeric | Immediate, serial port baud rate selector for Hurricane Hunter C130H aircraft. (0=300, 1=1200, 2=2400, 3=4800, 4=9600, 5=19200, 6=38400) |
| CommPortIndex | numeric | Immediate, serial com port selector for Hurricane Hunter C130H aircraft. (0=com1, 1=com2, … 7=com8) |
| ACagency | string | Immediate, agency designator in the TEMPDROP 61616 group. |
| MissionStorm | string | Immediate, storm designator in the TEMPDROP 61616 group. |
| MissionId | string | Immediate, mission id designator in the TEMPDROP 61616 group. |
| IcaoIndex | numeric | Immediate, index of ICAO designator (0=user defined, 1=KNHC, 2=KBIX, 3=KISX, 4=KHIK, 5=KTRR. For TEMPDROP messages. |
| AbrHdrOvr | string | Immediate, User defined overide for the abreviated header. For TEMPDROP messages. |
| AtcfId | String | Immediate, the ATCF cyclone or storm system |

| Element name | Type | Description |
|---|---|---|
| | | identifier. |
| OptIcao | numeric | Immediate, user defined optional ICAO identifier. For TEMPDROP messages. |
| UpsondeAbrHdr | string | Immediate, abbreviated header code (e.g. UUNA15) for upsonde messages. |
| UpsondeICAO | string | Immediate, ICAO code (e.g. KWBC) for upsonde messages. |
| TempEmailAddress | String | Immediate, email address that TEMP messages should be sent to. |
| DataDir | string | Directory where input data files are located. |
| WmoSaveDir | string | Directory to save WMO messages in. |
| QCSaveDir | string | Directory to save QC data in. |
| RawSaveDir | string | Directory to save raw data in. |
| XYPlotSaveDir | string | Directory to save XY plot graphics in. |
| SkewTPlotSaveDir | string | Directory to save Skew-t plot graphics in. |
| BatchSaveDir | string | For BatchAspen use, defines the diretory that output files will be written to. |
| BatchSaveRawCLS | bool | For BatchAspen use, set true to save the raw data in a CLASS format file. |
| BatchSaveQCCLS | bool | For BatchAspen use, set true to save the Q/C data in a CLASS format file. |
| BatchSaveRawCDF | bool | For BatchAspen use, set true to save the raw data in a netCDF format file. |
| BatchSaveQCCDF | bool | For BatchAspen use, set true to save the Q/C data in a netCDF format file. |
| BatchSaveRawCSV | bool | For BatchAspen use, set true to save the raw data in a CSV format file. |
| BatchSaveQCCSV | bool | For BatchAspen use, set true to save the Q/C data in a CSV format file. |
| BatchSaveWMO | bool | For BatchAspen use, set true to save the WMO message in a text file. |

**Table 4. Configuration Parameters**

# Appendix B: File formats

An overview of the output file formats is given here. The file structures are sraightforward, and examination of the files will provide most of the documentation on their formats.

Note that the file formats are not complete; i.e one format will contain information that another format does not support. Thus, the CSV and netCDF formats can document the configuration parameters used in the processing, whereas the CLASS format does not support inclusion of this information.

## *CLASS Format*

The CLASS file starts with a 15 line header section, followed by a variable number of data lines. The data lines are arranged in fixed width columns. A mandatory set of 21 data parameters is reported, even though a number of these (specifically the "quality" values) are always marked with a missing value indicator.

The data is reported in the sequence of decreasing pressure, i.e. from the surface upward, regardless of the direction of the sounding.

## *EOL Format*

The EOL file starts with a 15 line header section, followed by a variable number of data lines. The data lines are arranged in fixed width columns. A fixed set of 17 data parameters is reported

The data is reported in the sequence of decreasing pressure, i.e. from the surface upward, regardless of the direction of the sounding.

## *NetCDF*

Section "Appendix D: netCDF Attributes" contains the attributes listing from an ncdump of an Aspen generated netCDF file. Note that for legacy compatibilty reasons, a number of unecessary variables are included in the netCDF file. The global attributes contain a record of the Q/C processing options.

## *Comma Separated Values (CSV)*

The "Comma Separated Value" file format is used for data interchange between Aspen and other software. It is a free form structure, with one data record per line, and the fields in a record separated by commas. A CSV file can be read directly into Microsoft Excel, and the data will be correctly organized in the spreadsheet.

For input to Aspen, certain conventions must be followed within the CSV file.

Each line begins with an identifier, followed by one or more fields. The order of the lines is generally not important, within the following guidelines:

- The first line must be:

```
FileFormat,CSV
```

- After the first line, the launch time **must** be provided on lines as follows:

```
Year,2001
Month,08
Day,01
Hour,17
Minute,58
Second,34
```

- The launch observation data may be provided in lines labeled with the parameter name.
- To designate a dropsonde sounding, include a line:

```
Ascending,"false"
```

- A "Fields" line defines the data fields and their order, for the succeeding "Data" lines. Aspen output CSV files will contain a fairly large number of fields, e.g.:

```
Fields,Time,Pressure,Temperature,RH,Speed,Direction,Latitude,     \
Longitude,Altitude,Dewpoint,Uwnd,Vwnd,Ascent
```

- For an input CVS file to be read properly by Aspen, the following data field conventions must be followed:

| Fields | Aspen utilization |
|---|---|
| time<br>pressure | These are required input data fields. |
| rh<br>rh1<br>rh2<br>speed<br>direction<br>latitude<br>longitude<br>altitude<br>ascent<br>sats<br>gpsalt | These data fields will be utilized, if provided. |
| others | Other data fields will be ignored on input. |

- The "Units" lines documents the units of each data field. Note that the units shown here must be adhered to; Aspen will not make units conversions. At least the time and pressure fields must be provided:

```
Units,sec,mb,deg C,%,m/s,deg,deg,deg,m,deg C,m/s,m/s,m/s
```

- The "Data" lines follow after all of the preceeding records.

Some other rules apply:

- Long strings should be enclosed in quotes.
- Don't include commas in strings
- Capitalization is not important.
- The data series must be ordered in time
- Time tags less than zero will be ignored
- Don't use reserved strings in the first field of a line.
- "Fields" must come before "Data"
- Missing data are simply represented by empty fields, i.e. two commas in succession, or a trailing comma on the end of a line, indicating that the last field is missing.

The following demonstrates a small CSV file (note that the line breaks are not found in the actual file):

```
FileFormat,CSV
Year,2001
Month,08
Day,01
Hour,17
Minute,58
Second,34
Pressure,57.6,"units=mb"
Temperature,-59.9,"units=deg                                                    C"
RH,,"units=%"
Speed,7.9,"units=m/s"
Direction,92.0,"units=deg"
Latitude,30.9909,"units=deg"
Longitude,-119.5005,"units=deg"
Altitude,19610.0,"units=m"
Ascending,"false"
Fields,Time,Pressure,Temperature,RH,Speed,Direction,Latitude,Longitude,
Altitude,Dewpoint,Uwnd,Vwnd,Ascent
Units,sec,mb,deg          C,%,m/s,deg,deg,deg,m,deg          C,m/s,m/s,m/s
Data,0.3,,,,,,,,,,,,
Data,0.8,,,,,,,,,,,,
Data,11.8,,,,11.52,69.53,,,,,-10.79,-4.03,
Data,38.8,71.06,-60.33,,8.23,104.25,30.99129,-119.50375,18295.7,,-
7.98,2.03,-39.94
Data,51.8,77.01,-63.75,,8.67,160.11,30.99174,-119.50441,17799.7,,-
2.95,8.15,-36.35
Data,66.3,83.86,-62.29,,,,30.99267,-119.50520,17276.1,,,,-35.06
Data,75.8,88.52,-64.99,,8.95,119.15,30.99295,-119.50592,16944.3,,-
7.82,4.36,-34.01
```

# Appendix C: System Requirements

Screen resolution: 1024x768 pixels or greater

Windows display: configured for small fonts

Free disk space: at least 20 MB

Processor speed: 500 MHz or better recommended

System memory: 256 MB RAM or greater

Operating system: Windows XP

# Appendix D: netCDF Attributes

The following shows the output of an ncdump command applied to an Aspen generated netCDF file.

```
netcdf D20010801_175834QC {
dimensions:
      time = 2122 ;
variables:
      int base_time ;
            base_time:long_name = "sounding launch time" ;
            base_time:units = "seconds since 1970-01-01 00:00:00 UTC" ;
            base_time:string = "Wed Aug 01 17:58:34 2001" ;
      float time_offset(time) ;
            time_offset:long_name = "seconds since base_time" ;
            time_offset:units = "seconds" ;
            time_offset:missing_value = -999.f ;
            time_offset:_FillValue = -999.f ;
      double time(time) ;
            time:long_name = "time" ;
            time:units = "seconds since 1970-01-01 00:00:00 UTC" ;
            time:missing_value = -999.f ;
            time:_FillValue = -999. ;
      float pres(time) ;
            pres:long_name = "pres" ;
            pres:units = "hPa" ;
            pres:missing_value = -999.f ;
            pres:field_type = "P" ;
            pres:_FillValue = -999.f ;
      float tdry(time) ;
            tdry:long_name = "tdry" ;
            tdry:units = "degC" ;
            tdry:missing_value = -999.f ;
            tdry:field_type = "T" ;
            tdry:_FillValue = -999.f ;
      float dp(time) ;
            dp:long_name = "dp" ;
            dp:units = "degC" ;
            dp:missing_value = -999.f ;
            dp:field_type = "T_d" ;
            dp:_FillValue = -999.f ;
      float rh(time) ;
            rh:long_name = "rh" ;
            rh:units = "percent" ;
            rh:missing_value = -999.f ;
            rh:field_type = "rh" ;
            rh:_FillValue = -999.f ;
      float u_wind(time) ;
            u_wind:long_name = "u_wind" ;
            u_wind:units = "m/s" ;
            u_wind:missing_value = -999.f ;
            u_wind:field_type = "uwind" ;
            u_wind:_FillValue = -999.f ;
```

```
float v_wind(time) ;
      v_wind:long_name = "v_wind" ;
      v_wind:units = "m/s" ;
      v_wind:missing_value = -999.f ;
      v_wind:field_type = "vwind" ;
      v_wind:_FillValue = -999.f ;
float wspd(time) ;
      wspd:long_name = "wspd" ;
      wspd:units = "m/s" ;
      wspd:missing_value = -999.f ;
      wspd:field_type = "wspd" ;
      wspd:_FillValue = -999.f ;
float wdir(time) ;
      wdir:long_name = "wdir" ;
      wdir:units = "degree" ;
      wdir:missing_value = -999.f ;
      wdir:field_type = "wdir" ;
      wdir:_FillValue = -999.f ;
float dz(time) ;
      dz:long_name = "dz" ;
      dz:units = "m/s" ;
      dz:missing_value = -999.f ;
      dz:_FillValue = -999.f ;
float range(time) ;
      range:long_name = "range" ;
      range:units = "km" ;
      range:missing_value = -999.f ;
      range:_FillValue = -999.f ;
float qp(time) ;
      qp:long_name = "qp" ;
      qp:units = "hPa" ;
      qp:missing_value = -999.f ;
      qp:_FillValue = -999.f ;
float qt(time) ;
      qt:long_name = "qt" ;
      qt:units = "degC" ;
      qt:missing_value = -999.f ;
      qt:_FillValue = -999.f ;
float qrh(time) ;
      qrh:long_name = "qrh" ;
      qrh:units = "percent" ;
      qrh:missing_value = -999.f ;
      qrh:_FillValue = -999.f ;
float qu(time) ;
      qu:long_name = "qu" ;
      qu:units = "m/s" ;
      qu:missing_value = -999.f ;
      qu:_FillValue = -999.f ;
float qv(time) ;
      qv:long_name = "qv" ;
      qv:units = "m/s" ;
      qv:missing_value = -999.f ;
      qv:_FillValue = -999.f ;
float qwind(time) ;
      qwind:long_name = "qwind" ;
      qwind:units = "m/s" ;
```

```
            qwind:missing_value = -999.f ;
            qwind:_FillValue = -999.f ;
      float mr(time) ;
            mr:long_name = "mr" ;
            mr:units = "gram/kg" ;
            mr:missing_value = -999.f ;
            mr:_FillValue = -999.f ;
      float vt(time) ;
            vt:long_name = "vt" ;
            vt:units = "degC" ;
            vt:missing_value = -999.f ;
            vt:_FillValue = -999.f ;
      float theta(time) ;
            theta:long_name = "theta" ;
            theta:units = "K" ;
            theta:missing_value = -999.f ;
            theta:_FillValue = -999.f ;
      float theta_e(time) ;
            theta_e:long_name = "theta_e" ;
            theta_e:units = "K" ;
            theta_e:missing_value = -999.f ;
            theta_e:_FillValue = -999.f ;
      float theta_v(time) ;
            theta_v:long_name = "theta_v" ;
            theta_v:units = "K" ;
            theta_v:missing_value = -999.f ;
            theta_v:_FillValue = -999.f ;
      float lat(time) ;
            lat:long_name = "north latitude" ;
            lat:units = "degrees" ;
            lat:missing_value = -999.f ;
            lat:_FillValue = -999.f ;
            lat:valid_range = -90.f, 90.f ;
      float lon(time) ;
            lon:long_name = "east longitude" ;
            lon:units = "degrees" ;
            lon:missing_value = -999.f ;
            lon:_FillValue = -999.f ;
            lon:valid_range = -180.f, 180.f ;
      float alt(time) ;
            alt:long_name = "altitude above MSL" ;
            alt:units = "meters" ;
            alt:missing_value = -999.f ;
            alt:_FillValue = -999.f ;

// global attributes:
            :bad_value_flag = -999.f ;
            :zebra_platform = "class" ;
            :history = "ClassNcFile" ;
            :AvapsEditorVersion = "2.3.1" ;
            :SoundingDescription = "D20010801_175834.3 011118097 AAVAPS
Flight Test, EAFB Flight Test 3 Lockheed ER-2, NASA 809" ;
            :ACagency = "AF001" ;
            :ACtype = "0" ;
            :AbrHdrOvr = "0" ;
            :AutoFile = "1" ;
```

```
:BSN = "99999" ;
:BaudRateIndex = "2" ;
:CallSign = "CALL" ;
:ChuteArea = "676" ;
:CommPortIndex = "0" ;
:DoLevels = "1" ;
:DoQC = "1" ;
:DoWMO = "1" ;
:DropSondeMass = "395" ;
:DropsondeHitSfc = "1" ;
:ExcludeAbrHdr = "0" ;
:IcaoIndex = "1" ;
:MissionId = "TRAIN" ;
:MissionStorm = "WXWXA" ;
:OptIcao = "W" ;
:PlotFileFormat = "0" ;
:PlotPixelsX = "1000" ;
:PlotPixelsY = "700" ;
:PosInterpSpan = "60" ;
:PresBuddySlope = "2" ;
:PresOffset = "0" ;
:PresOutlier = "10" ;
:PresQCDev = "3" ;
:PresQCWL = "10" ;
:PresSmoothWL = "5" ;
:QCSaveDir = "C:\\tmp\\ER-2" ;
:RHBuddySlope = "20" ;
:RHOffset = "0" ;
:RHOutlier = "10" ;
:RHQCDev = "3" ;
:RHQCWL = "10" ;
:RHSmoothWL = "5" ;
:RHchoice = "0" ;
:RawSaveDir = "C:/" ;
:SetHtsMissing = "0" ;
:SfcAltUnknown = "1" ;
:SfcAltitude = "0" ;
:SkewTPlotSaveDir = "C:/" ;
:TdryBuddySlope = "3" ;
:TdryDynCor = "0" ;
:TdryOffset = "0" ;
:TdryOutlier = "10" ;
:TdryQCDev = "3" ;
:TdryQCWL = "10" ;
:TdrySmoothWL = "5" ;
:TempMsgType = "0" ;
:WindBuddySlope = "5" ;
:WindDynCor = "0" ;
:WindOutlier = "10" ;
:WindQCDev = "3" ;
:WindQCWL = "10" ;
:WindSats = "3" ;
:WindSmoothWL = "10" ;
:WindVVdelta = "2.5" ;
:WmoSaveDir = "C:/" ;
:XYPlotSaveDir = "C:\\tmp" ;
```